Supply Chain Strategies for an online Supermarket

MASTER THESIS

July 27, 2016

COLLEGE OF MANAGEMENT OF TECHNOLOGY

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

David Castellanos Imas

Prof. Philippe Wieser, Master Thesis advisor

Acknowledgements

I would like to thank some people without whom this project would not have been possible. First of all, I would like to mention my family for their constant support. On the other hand, I would also like to thank my friend Marta Pardo for her collaboration, giving her point of view whenever I asked for it, and advising me whenever she felt it necessary.

Finally, last but not least, I would like to thank my advisor Philippe Wieser for his help and his advice throughout the evolution of this project.

Lausanne,

July 27, 2016

Abstract

In recent years, supply chain management has become increasingly important in the industrial sector. Currently, everyone is aware that a good supply chain performance is essential to business success.

This project tries to help people willing to know, in a fast way, how the heightened expectations of customers have forced business enterprises to focus attention on their supply chains. These expectations require companies to develop supply chain strategies. According to this, a good management of the supply chain helps the company to offer the right product to the right place at the right time.

And to do that, brilliant and helpful sources have been consulted, being the basis on which this research has been built.

In this project, the research is separated in two parts:

The first part is based on theoretical background. We briefly introduce what supply chain management is. Thus, we explain concepts, insights and decisions for the effective management of the supply chain, in order to better understand the second part of the study.

The second part refers to a business case. The theory learnt so far is applied to a newly created online supermarket. It is about answering key questions about how the company must structure itself. The aim of this second part is to explain the aspects that must be taken into account at the moment of designing the supply chain of the company, and how these influence the development of entrepreneurial activity.

Finally, once we have analyzed the whole supply chain, we draw relevant conclusions about what are the best choices depending on specific features of the marketplace.

Contents

List of Figures

List of Tables

PART I. THEORETICAL BACKGROUND

Chapter 1 Introduction

The introduction of Internet in the business world has meant that companies try to expand their market share with a wider geographical coverage, product customization and differentiation based on the level of customer service and price competitiveness.

Nevertheless, the companies have large problems to distribute their products at a reasonable price and a good level of service.

The **Business to Consumer** (B2C) has boosted the logistical requirements throughout the entire supply chain, insomuch as:

- On the one hand, much of the suppliers do not have their logistics systems adapted to handling and delivery of small volumes.
- And secondly, home delivery is very costly because of most deliveries must be made in conditions and with appropriate means.

Note that the online stores must face major investments in their storage and distribution centers, and transportation costs are too high for the low level of demand.

A large percentage of online orders are generated in major cities, which shows that the challenge for the companies is not the distribution in remote locations, but the ability to make an efficient distribution to home of an urban customer.

The congestion present in most European cities produces decreased average speeds of traffic and, consequently, a significant reduction of the service level and the delivery vehicles performance. The significant increase of mobility has caused that congestion, which once focused heavily on certain peak hours, it has spread to other times of the day, with a congested city for most of the workday.

In the e-commerce, deliveries are not made on the ground floor but they are made on the upper floors of buildings that often have no elevator. On the other hand, there sectors such as grocery industry, where the times of reception are much higher than those currently they have other.

All these aspects, together with the temporary concentration of deliveries in periods of the day that often coinciding with the highest levels of congestion, impose needs of economic, technical and human resources throughout the supply chain network.

The main cause of the concentration of deliveries is that online consumers are usually young professionals looking to avoid long queues in stores and take advantage of the convenience of home delivery, but paradoxically, that they are very few hours a day on their homes. This kind of customer appreciates the convenience of service but not willing to pay or, at best, they would pay a minimum price for that service.

Due to this type of target consumer in this online channel, the company has to provide a high service level based on delivery orders through restricted time windows, which have significantly impact on distribution costs. The impact level of these windows depends, among other things, on the number and size of these, the time of distribution and the volume of demand for temporary windows most requested.

In the case of grocery industry, the combination of these restricted windows with low rates of service generates a half-empty circulation of vans in the cities or a significant downtime during the distribution. This logistic model may be feasible for low levels of demand, but hardly sustainable for significant volumes of business.

Another feature of e-commerce is that unloading the vans are concentrated in areas which are not usually prepared for such operations, and generates a new demand that aggravates the current deficiency of specific places for this purpose. Thereby, the road infrastructure and loading and unloading operations are fundamental for the efficient performance of the distribution. In this sense, the trend toward urban recovery of the old towns, which are characterized by have narrow paths, glimpses a focus of problems for distributors. The local government has to regulate and control that type of operations.

The analysis of the problem must be approached by sectors due that there is a wide range of variables that define the impact of the distribution on the urban areas. The main variables are the types of product, order, service and demand and the characteristics to be considered in each one are:

- Product: maintenance needs, handling and transportation.
- Order: picking-packing needs, the volume and transport.
- Service: the distribution model, the type of reception and the level of service offered.
- Demand: stability, seasonality and the geographic distribution.

OBJECTIVES:

The main objective of this project is to analyze a methodology of distribution logistics for a B2C company in Barcelona's urban area. The purpose is to comprehend how design a network distribution in a virtual store which offers delivery services with temporary windows. The project also serves as a tool to assess resource requirements as well as the costs generated through the company's service.

The project is divided as described below:

Theoretical part:

The first objective of the theoretical part is to understand the e-commerce and its current situation in Spain.

Once defined this type of business, the following objective is to understand the meaning of supply chain, the main concept of this project. Thereby, it is defined a supply chain and explained the impact that supply chain decisions have on a company's performance. In this way, it is provided a strategic framework to analyze decisions when are designing supply chain processes taking into account key aspects as facilities, inventory management and transportation. As it will be seen, a good management of the supply chain helps the company to offer the right product to the right place at the right time.

In concluding the theoretical part, it is exposed the routing optimization problem. It arises when customers demand a service and we should find the best way to satisfy them. Indeed, these problems serve to design of routes for vehicles in an urban area.

Business case:

After having found a niche in the market, it has been decided to create an online shop. With the aim of competing against the traditional supermarkets which already exist, the company buys directly from the manufacturer and stores the products in anticipation of the clients' demands. The company must decide whether transportation from a supply source will be direct to the demand point or will go through intermediate consolidation points.

The business case is about answering questions about how the company must structure itself, for instance:

- What are the advantages of selling food products via the Internet?
- What are the differences compared to the traditional trade?
- Must the company store all the products that it sells? Is it appropriate to use outsourcing?
- Where must the distribution centre be located?
- How will the merchandise be distributed in the city where the company operates?

Chapter 2 E-commerce

Electronic commerce, also written as e-commerce, is a type of business transaction in which the parties (companies and consumers) interact through electronic networks, typically the Internet. Almost any product or service can be offered via e-commerce, from books and music to financial services and plane tickets.

The Internet boom has brought associated new business models. These new models are called according to the agents involved. In this way, electronic commerce operates in all three of the major market segments:

- **Business to Business (B2B)**: Is a type of commerce transaction that exists between businesses, such as those involving a manufacturer and wholesaler, or a wholesaler and a retailer. An example that illustrates this model is automobile manufacturing. Many of a vehicle's components are manufactured independently and the auto manufacturer must purchase these parts separately.

- **Business to Consumer (B2C)**: In this type of commerce the transaction is directly between a company and consumers who are the end-users of its products or services. The B2C term became popular during the dotcom boom of the late 1990s, when it was used mainly to refer to online retailers, as well as other companies that sold products and services to consumers through the Internet. Nowadays, the most B2C leaders are Amazon, Alibaba and Ebay.

- **Consumer to Consumer (C2C)**: Is a business model that facilitates an environment where customers can trade with each other. This model is projected to grow in the future because of its cost-effectiveness.

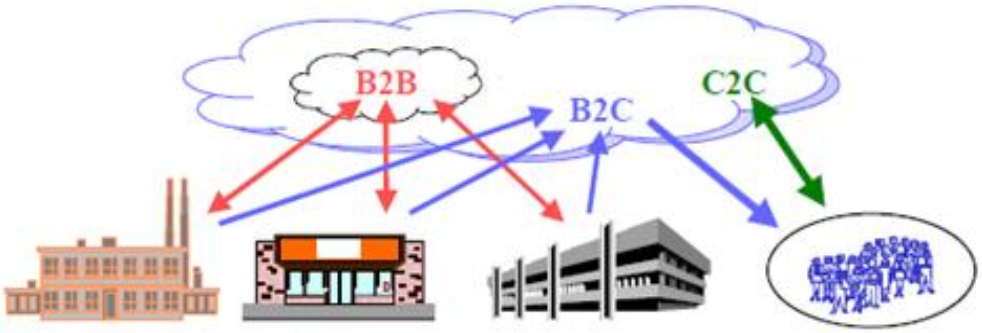

Figure 1. Main relationships in E-commerce

As a summary, the following table is shown in order to better understand the different relationships between the agents involved. It also gives an example of real companies.

	Targeted to consumers	Targeted to businesses
Initiated by business	B2C (Amazon)	B2B (Commerceone)
Initiated by consumer	C2C (eBay)	C2B (Priceline)

Table 1. Main relationships in E-commerce

Since the business case (Part 2) is an online store, we can assert that we will operate under a Business to Consumer model. For this reason, in the following section we will explain the situation in Spain regarding this type of business.

2.1 Business to consumer in Spain

To study the current situation we have consulted the official document of the Study about B2C e-commerce in Spain, published by ONTSI and the Government of Spain.

According to the report by ONTSI, in 2014 the total volume of e-commerce in Spain reached 16,259 million Euros. This means an increase of 11.3% compared to 2013. E-commerce continues to expand, with annual growth of more than two digits, although the pace slowed in the last year.

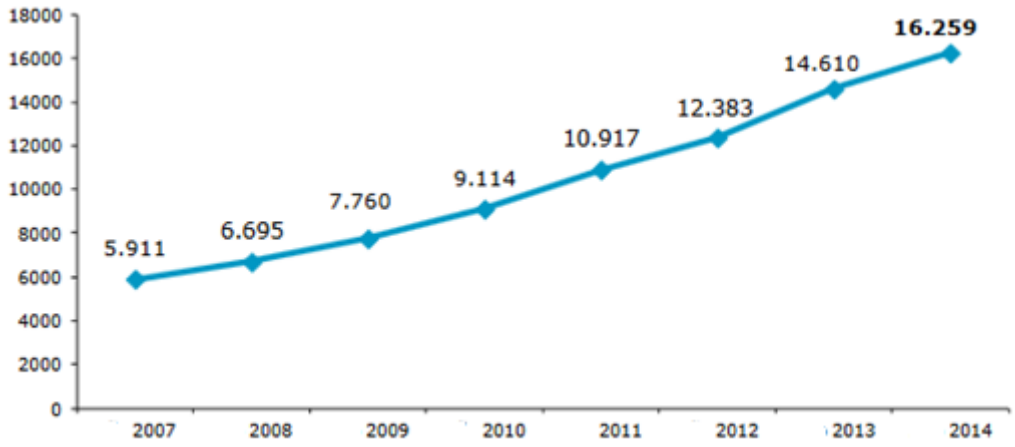

Figure 2. Evolution of B2C in Spain

The study reveals that the sector is growing due to the positive evolution of the 3 main variables used to estimate the volume of B2C:

- The number of Internet users, which are estimated at 29.9 millions.
- The proportion of Internet users who buy online, which are estimated at 18.6 million by early 2015.
- The average spending per buyer, which is 876€.

In short, the volume of e-commerce in 2014 is explained as follows:

% Internet users	76.1 %	29,9 MM people
% Internet buyers	62.0%	18,6 MM people
Average spending per buyer	876€	
TOTAL	16.259 MM€	

Table 2. Volume of e-commerce in Spain (2014)

Then we outline each of the variables separately in order to understand how they have contributed in electronic commerce.

INTERNET USERS

The current number of Internet users is estimated at 29.9 million, which means 76.1% of the Spanish population over 15 years.

Then we will analyze the main characteristics of these users:

- **Experience using Internet**

  A 79.2% of users have more than 3 years using Internet, while, at the other end, only 5.0% has been released less than a year ago.

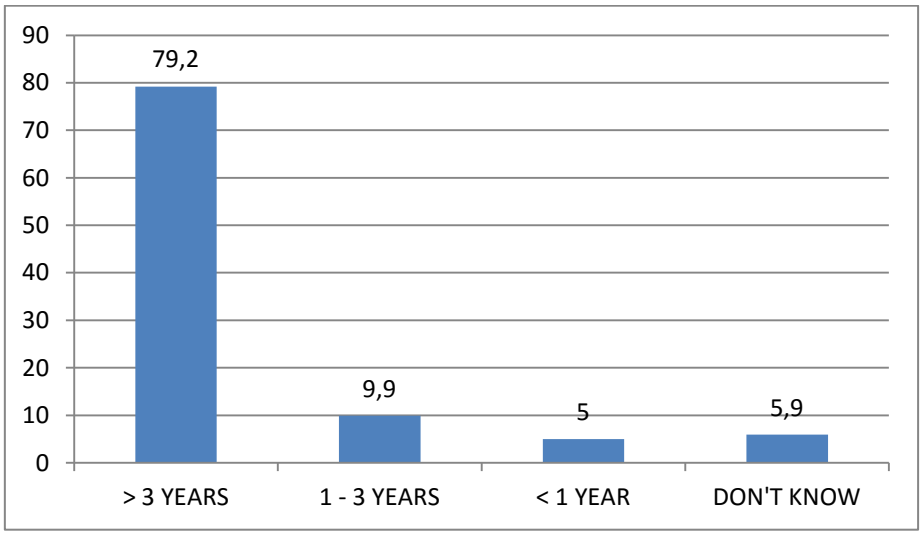

Figure 3. Users with experience in Internet (%)

- **Internet usage**

  The frequency of Internet use increases annually. A 74.4% of users report a daily use of the Internet, while 11.9% report at least a weekly use.

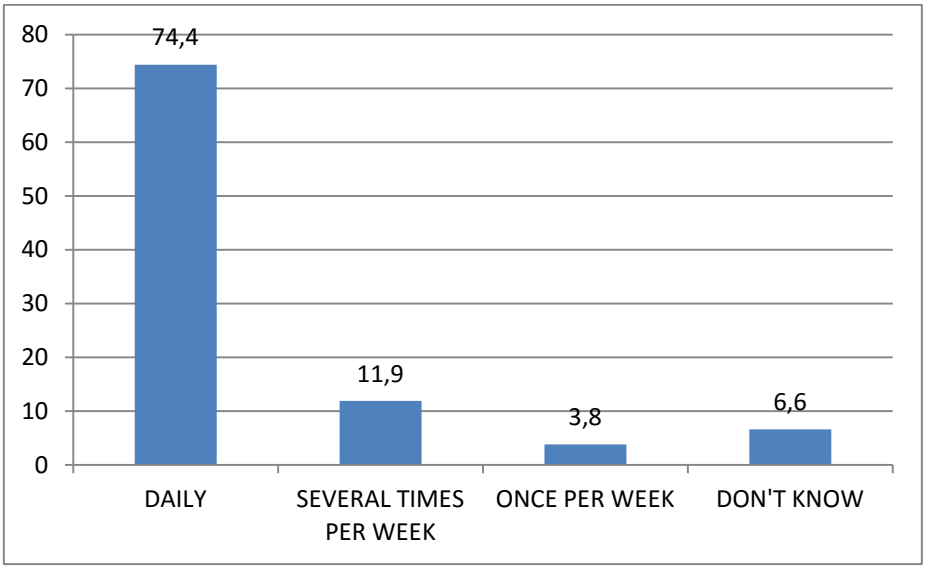

Figure 4. Frequency in Internet (%)

ONLINE CUSTOMERS

Of total users, a 62% report that they have made purchases of product through Internet. In absolute numbers, they represent 18.6 million people, an 8% more than the previous year.

The profile of these buyers answers the following socio-demographic characteristics:

- Some male predominance
- Strong concentration in the segment between 25 and 49 years old
- With secondary and university studies
- From high, medium-high and medium social class
- Active workers in a full-time working day
- Residents in capitals and major cities

	INTERNET USERS (%)	ONLINE CUSTOMERS (%)
GENDER		
Man	50,7	**53,9**
Woman	49,3	46,1
AGE		
15-24	14,5	13,3
25-34	19,9	**24,8**
35-49	35,6	**38,7**
50-64	20,5	17,0
>65	9,5	6,1
SOCIAL CLASS		
High	30,6	**36,8**
Medium	40,7	39,7
Low	28,7	23,7

Table 3. Profile of Internet users (%)

Another important thing to note is that 92.5% of buyers tend to use the same website to purchase on Internet.

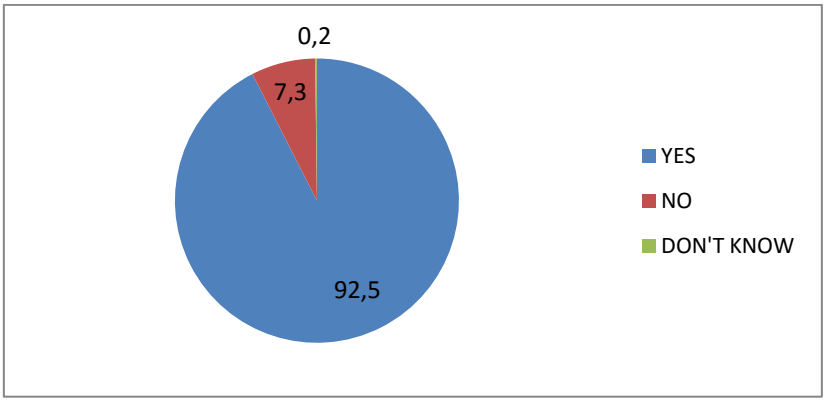

Figure 5. Users who use the same website to purchase (%)

That fidelity is mainly justified on economic reasons, and secondly, on the quality and variety that the website offers.

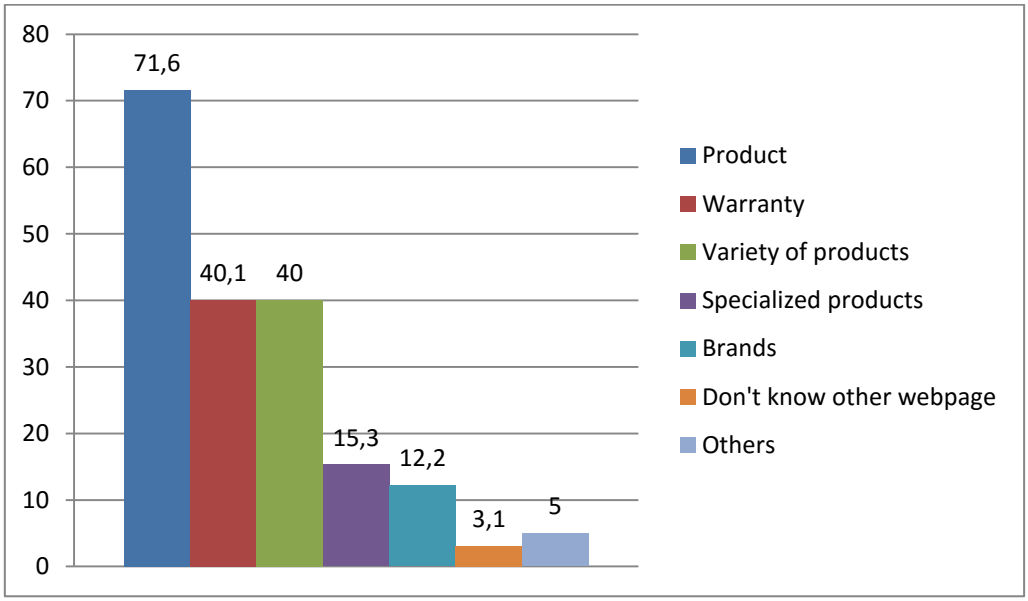

Figure 6. Fidelity on Internet (%)

Before a customer decides to make an online purchase of a product or service, usually they perform a search process. As shown in the Figure 7, the process normally be done online, but can also be by visiting a physical store or through referrals from friends and family.

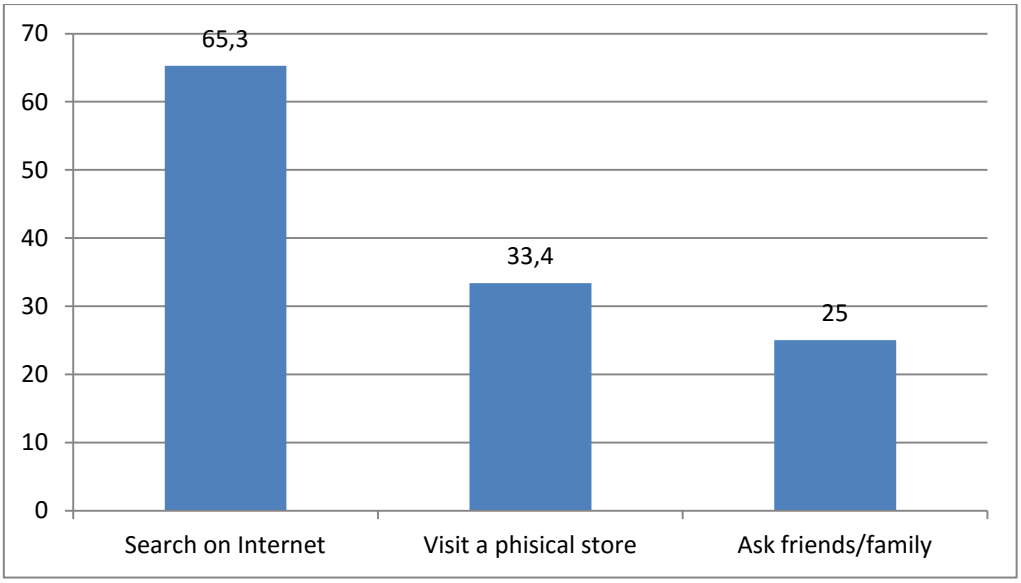

Figure 7. Decision before to make an online purchase (%)

Here is shown the most popular products on the Internet. It can see how the grocery industry occupies 14.5% of all online purchases, equivalent to 2,687,817 million customers. These buyers spent 873 million Euros in 2014.

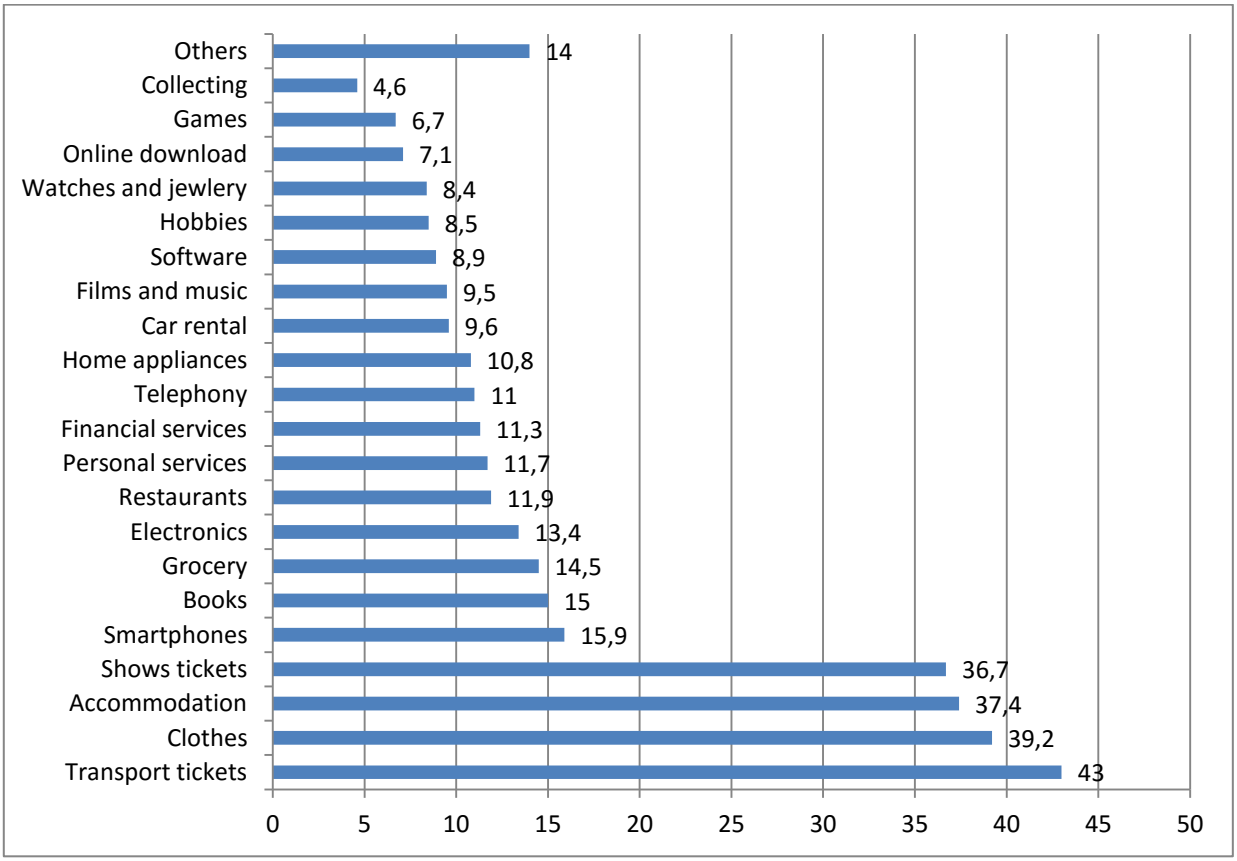

Figure 8. Goods and services (%)

The profile of online customers of food items is characterized by the following features:

	Man	Woman	15-24	25-34	35-49	50-64	>65
Transport tickets	41,2	45,2	44,5	45,9	37,8	43,5	59,6
Clothes	36,7	42,1	55,2	42,1	40,7	27	16,3
Accommodation	37,4	37,5	25,4	44,3	37,1	37,6	37,9
Show tickets	37,5	35,7	35,1	42,4	35,5	33,5	33,1
Smartphones	19,1	12,1	21,3	16,2	16,3	11,9	11,2
Books	13,6	16,6	13,8	13	15,1	16,1	21,8
Grocery	**12,7**	**16,6**	**12,6**	**18,4**	**13**	**14,4**	**12,1**
Electronics	19,6	6,1	14,4	14,1	15,5	10,5	3,5
Restaurants	12,7	11	12	15,1	10,4	11	10,8

Table 4. The profile of online customers (%)

Finally, as a summary:

	% Buyers	Total buyers	Times per year (average)	Spending (average)	Total spending
Transport tickets	43	7.985.566	3,23	466,02	3.721,4
Financial services	11,3	2.104.027	5,07	1.743,50	3.668,4
Accommodation	37,4	6.949.075	2,38	485,44	3.373,4
Clothes	39,2	7.270.553	3,25	160,48	1.166,8
Grocery	**14,5**	**2.687.817**	**4,23**	**324,83**	**873,1**

Table 5. Total spending on Internet.

Chapter 3 An introduction of supply chain

The aim of this chapter is to understand the meaning of supply chain. Thereby, we define a supply chain and explain the impact that supply chain decisions have on a company's performance.

Furthermore, we expose interesting information that need to be considered. In this way, we provide a strategic framework to analyze decisions when are designing supply chain processes.

3.1 What is supply chain

Several definitions of a supply chain have been described in the recent years. The following definition of supply chain was borrowed from Ganeshan and Harrison:

> *"A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers"*

After searching some of them we can define a supply chain as the network created amongst different companies producing, handling and distributing a specific product. That network consists of all parties involved in satisfying a customer request through moving the product from supplier to customer. The supply chain includes not only the manufacturer and raw material suppliers, but also carriers, distribution centers, retailers and even customers themselves (Lummus and Alber, 1997).

It should not be forgotten that the customer is an essential part of the supply chain. In fact, the primary purpose of any supply chain is to satisfy customer needs and, in the process, generate profit for itself.

When we talk about the supply chain, also it can be defined how to manage it. Several authors have also defined the concept of **Supply Chain Management** (SCM for short). As defined by Poirier and Bauer, supply chain management refers:

> *"Methods, systems and leadership that continuously improve an organization's integrated process for product and service design, sales forecasting, purchasing, inventory management, manufacturing or production, order management, logistics, distribution and customer satisfaction."*

Indeed, supply chain management coordinates and integrates all of supply chain activities into a unique process. A key point is that the entire process, from the original supplier to the end customer, must be viewed as one system.

The goal of a supply chain management is to achieve:

- The products are available when they are needed, thereby reducing the need to store large amounts of inventory.
- The reductions of costs along the entire supply chain in order to offer a more competitive product and increase benefits.

In order to understand better the concept explained above, we provide two conceptual maps, shown in Figures 8 and 9.

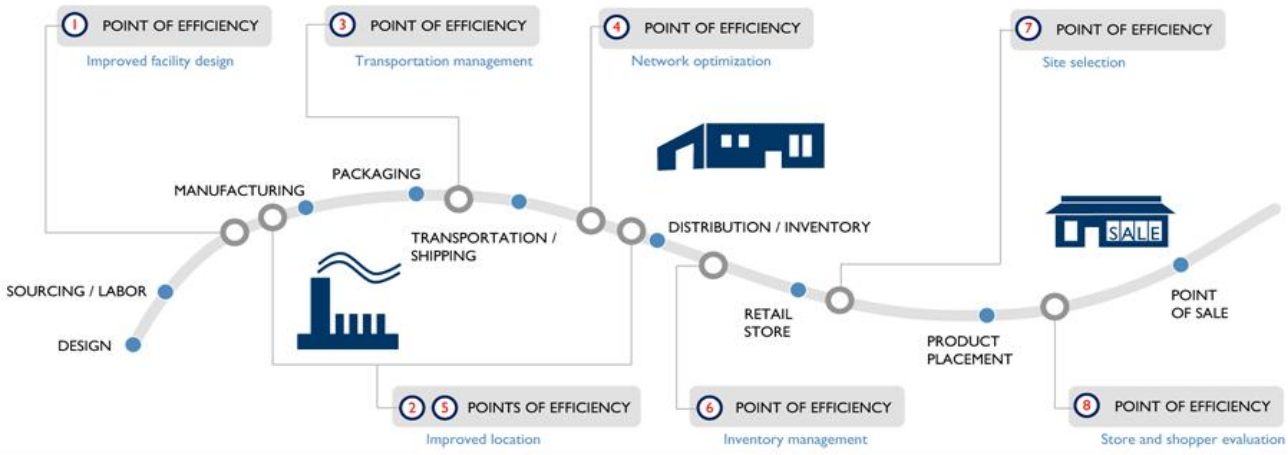

Figure 8. Supply Chain network. The flow of goods from design to sale

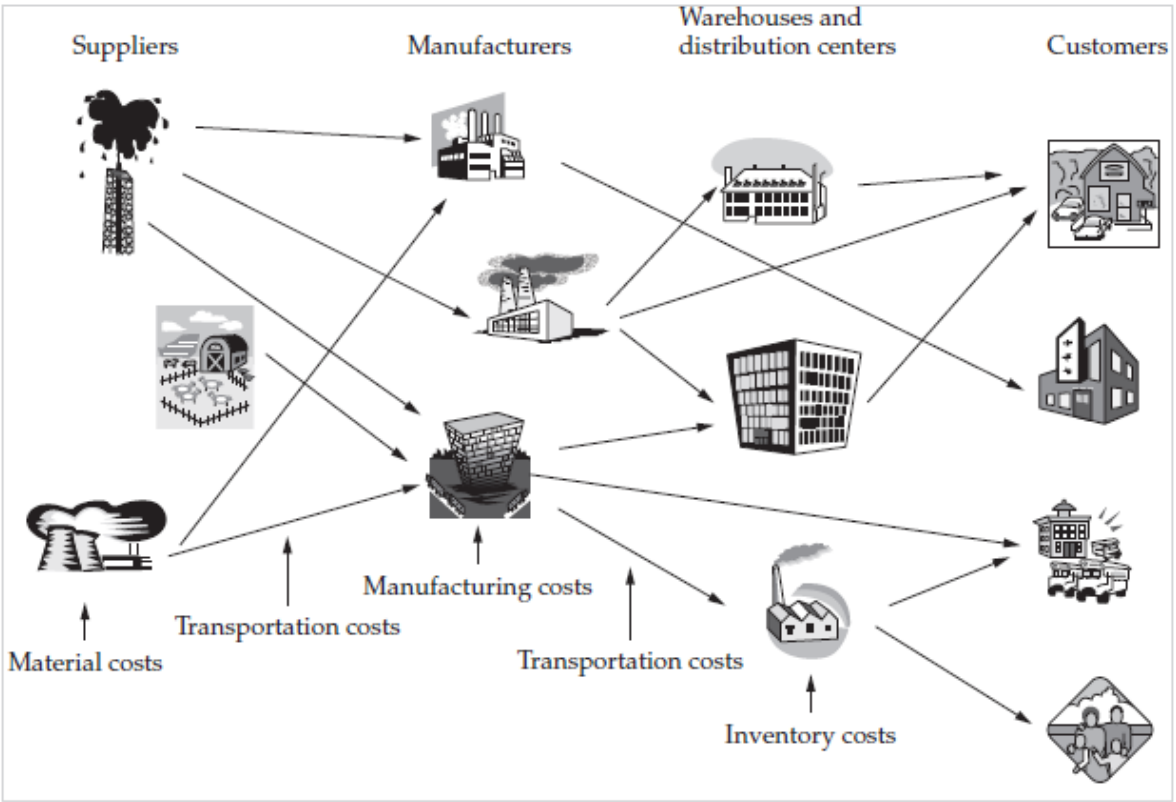

Figure 9. The logistics network

As it might be seen, the supply chain involves a variety of processes and agents which are connected each other through the flow of products, information and funds. This flow goes from design to sale of goods.

.

3.2 Process view of supply chain

Depending on how you want to supply the products and the timing of execution, these processes can be seen as a Pull or Push system. Thus, the processes are carried out in response to a customer request (Pull) or in anticipation of the customer request (Push). Although in many cases you may need a Push-Pull mixed strategy.

- **PUSH**: With push processes, execution is initiated in anticipation of customer requests, this means that the demand is not yet known. Because of this, it is forecast the necessary inventory to meet customer demand. Companies must predict which products will be sold and the amount of these. As the company operates in an uncertain environment, it must produce enough products to meet forecasted demand and sell, or push, the products to the consumer.
  Definitely, the goal of this methodology is to guarantee product availability when a customer request arrives.

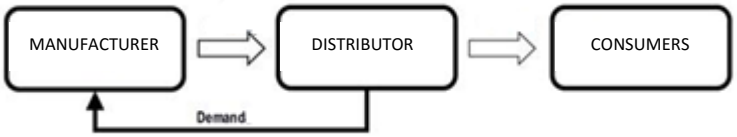

Figure 10. Push view

- **PULL:** The Pull system begins in response to a customer requests. In this case, customer demand is known with certainly. With this strategy, companies only have enough products to meet customer orders. An advantage of this system is that there will be no excess inventory that needs to be stored, thereby reducing inventory levels and costs of transport and storage of goods.

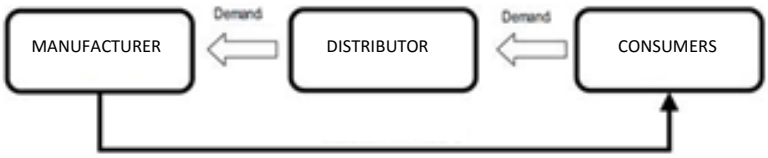

Figure 11. Pull view

3.3 The objectives of a supply chain

The main objective of every supply chain is to maximize the total value generated. This value is also called as **supply chain surplus** (this term was defined by Sunil Chopra and Peter Meindl), which is understood as the difference between what the product sold is worth to the customer and the cost that the supply chain incurs in accomplishing the customer's request (the cost of produce and deliver the product).

In terms of profitability, the value obtained is the difference between the **revenue** generated from the customer and the **total cost** across the supply chain.

Therefore, while the only source of revenue is the customer, we should consider all the costs involved in movement and storage of products until they are sold to this end customer. The most important are: storage, inventory, internal transport, finished goods distribution, and personnel involved in these tasks.

3.3.1 Succes through a supply chain management

Currently, the world economy is connected through the Internet, which has led to increased expectations of the end customer. Customer satisfaction has become critical to business growth and profitability. These expectations require companies to develop supply chain **strategies** taking into account the physical location of the warehouses, the use of sophisticated software systems, and so on.

These strategies, as well as planning and design of the flow of goods and information from the point of origin to point of consumption are some of the essential components of Supply Chain Management. Therefore, we can say that there is a direct relationship between the way as the supply chain is managed, and the success of the companies.

Through efficient logistics management could increase productivity and performance of companies. In this way, and in order to prove some examples, by creating partnerships with suppliers or connecting service through automated systems, companies could be improved by reducing overhead costs and making faster delivery.

According to the above, a good management of the supply chain helps the company to offer the right product to the right place at the right time.

3.4 Supply chain network design and management

Balancing responsiveness to market needs with overall efficiency is an important aspect to consider when you are designing a supply chain network. Thus, through supply chain strategies aim to increase the company's performance in terms of responsiveness and efficiency.

- An **efficient supply chain** is characterized by longer production lead-times, high set-up costs, and larger batch sizes. These characteristics allow the company to produce at a low unit cost. Consequently, this strategy depends directly of market responsiveness.

- A **responsive supply chain**, in contrast, is characterized by short production lead-times, low set-up costs, and small batch sizes that allow the company to adapt quickly to market demand, but often at a higher unit cost.

Identifying strategies that achieve responsiveness and efficiency simultaneously is the goal of companies. To reach this goal, a company must make strategic decisions in accordance with the following main elements:

- Facilities
- Transportation and distribution network

In the following sections we discuss the role that each element plays in the supply chain.

3.4.1 Facilities

Facilities are those physical locations in the supply chain network where the product is manufactured (production sites) or stored (storage sites). These kinds of facilities have a fundamental impact on the overall success of the supply chain, and it is why you must make an optimal design of them.

The company that we are analyzing does not produce products, only stores and delivers them. That is why we only explain the design of storage facilities. Thereby, these facilities can be subdivided into warehouses and distribution center (DC).

Then the differences between the main features of a warehouse and distribution center are shown:

- The main function of a **warehouse** is to manage the storage and handling of inventory (mismatches between production and consumption). The main purpose focuses on space optimization.
  In this case, shipments are made under customer demand and the order cycle can be weekly or monthly.

- The main function of a **distribution center** is to manage the flow of materials. The optimization focuses on a rapid flow of these materials and the labor of Picking.
  Shipments are made according to a push system. The order cycle is days or even hours.

Companies manage these facilities to keep stock in anticipation of or to react to the demand for products (Chapter 3.2).

Companies must define the design of its storage facilities depending on the area which will be covered, the population's characteristics, and the demand, among others. Also the network should also take into account the routes to and from the production plants. This means that aspects such as **location** and **capacity** are essential in the design of the facilities.

The location of facilities is an important decision because there are many issues to consider: the distance from the warehouse to customers as well as to suppliers (that should be the minimum possible to save transportation costs of products), type of transport to be used (by land, sea, air...), the accessibility (the place should be well connected), the cost of facility (in relation to the initial investment), and other strategic factors.

Once a facility is located in a particular place must be managed its capacity, that is, decide what size it should have. If the facility has more capacity, the cost of its management will also be higher. Conversely, if the facility is too small, perhaps the company cannot store enough demanded products, causing a rupture of stock. For these reasons, the choice of storage capacity also becomes one of the strategic decisions of the company. Therefore, as will be seen below, it should make a good forecast demand (Chapter 7.4).

Note that the decision should be made considering the location as well as the type of the facilities and the level of responsiveness that these facilities provide the customers.

3.4.2 Inventory

Inventory is the finished goods held by storage sites (warehouses and distribution centers), and which are ready for sale. Thereby, inventory exists because of a mismatch between offer and demand.

Thus, inventory management can be defined as the overseeing and controlling of quantities of finished products for sale. The fundamental goals of this management are:

- Ensure the availability of items when they are ordered by customers. Therefore, inventory has a great impact on responsiveness. Inventory also has a significant impact on the material flow time.
- Reduce stock level in order to keep the lowest product levels in warehouse. It has to be noted that inventory is a major source of cost in a supply chain.

Hence, there are basic reasons for keeping an inventory: increase the amount of demand that can be satisfied by having always the product available, reduce costs by exploiting economies of scale and reduce uncertainty in demand. But

also, some authors mentioned several reasons not to keep high inventory levels such as the product obsolescence and the capital investment. Thus, holding inventory just in case it is needed is a highly costly activity.

The company should take into account all these issues in order to make a competitive strategy based on responsiveness (more inventory) or efficiency (less inventory).

Finally mention that there are two common inventory management strategies: the just-in-time method (JIT), where the company plan to receive items when they are needed rather than maintaining high inventory levels, and Materials Requirement Planning (MRP), which schedules material deliveries are based on sales forecasts.

3.4.3 Transportation and distribution network configuration

Products have to be transported in some way from production to consumption. Thus, transportation is required to move products between different stages in the whole supply chain. It should be clear that the transport operation determines the efficiency of the supply chain network.

Companies must make strategic decisions in order to improve factors such as the service quality, preciseness, delivery speed, and so on. Ultimately, the most important thing is to find a balance between the cost of transporting a product and the speed with which that is product is transported. However, it must also consider that transport is the largest component of the cost structure of logistics.

Therefore, companies must design the distribution taking into account different issues such as the different modes of transport and routes by which product will be shipped (Chapter 5).

Companies have to choose the mode in which their products are moved from one location to another. Modes of transport include air, land (rail and road), water and pipeline. Therefore, the choice is a fundamental part of distribution management which should be analyzed carefully according different aspects.

3.5 Decisions to outsource logistics activities

Retailer's aim is selling directly to the customer – its focus is marketing and sales, but sometimes without the capability to fulfill orders. Because of this, companies must decide which tasks will be carried out with its own resources and those that will be outsourced.

Logistics outsourcing may be defined as the process that involves the use of external companies to perform logistics functions that have traditionally been performed within an organization (Hsiao *et al.* 2010). A third-party logistics provider (3PL) is a company which provides outsourced services, at least transportation management and warehousing (Holter *et al.* 1993).

It should be mentioned that the strategic reasons for outsourcing logistics activities are based on operational improvement, and cost reduction. Other main objectives are minimizing inventory in-transit and improve the service through more accurate delivery information and on-time delivery performance.

Thus, in order to achieve more efficiency, responsiveness and competitive advantages in the marketplace, companies need to focus on customer satisfaction. They often outsource different business tasks such as information technology (IT) or customer service. They also have to take into account one of the most important steps in the process: the delivery of products to the customer's home, i.e., transport management, which is the highest logistics cost. Thus, issues such as delivery time and order fulfillment affect the quality of the transport service.

A good example could be the outsourcing of next-day package delivery -which is originally performed in-house because it is too expensive for the own company.

Chapter 4 Network models

The routing optimization problem arises when customers demand a service and we should find the best way to satisfy them. Indeed, these problems serve to design of routes for vehicles in a urban area. Typical examples include mail delivery, garbage collection or school transportation; although these problems can not only be applied in logistics and distribution, but also serve to model other situations such as the production of integrated electronic circuits or sequencing tasks.

There are many types of routing problems; according to additional restrictions are imposed (number of vehicles, customer location, time windows, vehicle capacity, type of service required, etc.).

In Table 6 are the most important types of problems paths along with the names that have historically received.

	RESTRICTIONS	PROBLEM	OTHER RESTRICTIONS
NODES	NO	Travelling Salesman Problem (TSP)	
	YES	Vehicle Routing Problem (VRP)	
ARCS	NO	Chinese Postman Problem (CPP)	Time windows
	YES	Capacitated VRP	

Table 6. Most important types of problems

As can be seen in the table, there are two major types of problems according to customers' routes lie on the nodes or arcs:

- In the first case, the goal is to determine the optimal route to visit all nodes in order to provide some delivery and collection service of goods.

- In the second, the route must travel all the arcs of the graph that defines the problem. That is, the routes should be designed so that it passes through the streets of a neighborhood or a specific part of a city.

In other words, the problems on the nodes it is understood that each customer is represented by a node while problems on arches it is understood that the arcs are streets to be visited. These two kinds of problems are known as node-covering and edge-covering, respectively.

Node covering problems have their origin in the 18th century when the Irish W.R. Hamilton and T. Kirkman British invented the so-called "The Icosian Game". This game consists of the following graph:

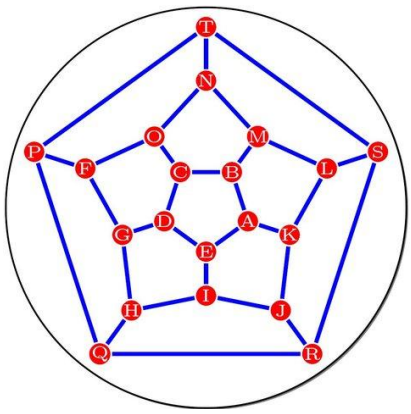

Figure 12. Hamilton's Icosian Game

The aim is to determine a path that passes through all of the 20 vertices once and only once, and then returns to the starting point.
In a world based on this dodecahedral graph, a traveler must visit 20 cities, without revisiting any of them. Today, when such a trip makes a loop through all the vertices, or corners, of the graph, it is called a Hamiltonian tour (or cycle). When the first and last vertices in a trip are not connected, it is called a Hamiltonian path.

The history of the two major node covering problems (Traveling Salesman Problem and Vehicle Routing Problem) is closely related. In fact, historically the VRP has been understood as a generalization of the TSP, as will be seen later.

In order to better understand these problems, we mention the following examples in daily life: distribution of newspaper to kiosks, daily routing of school buses and the delivery of mail packages.

By contrast, **edge covering problems** have their origins in the 18th century when the population of the city of Königsberg, now a small town in Russia, began to discuss whether there was any route that pass only once by 7 bridges crossing the Pregel River and returned to the starting point (Figure 13). This problem was proposed by the Swiss mathematician Leonhard Euler, who proved that has no solution.

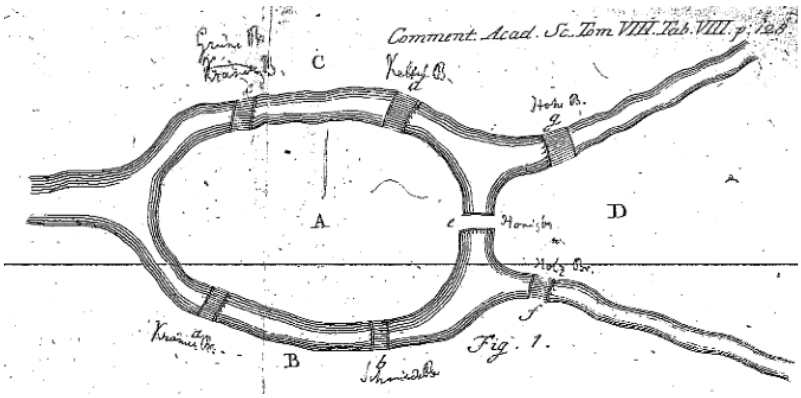

Figure 13. Seven Bridges of Königsberg

Specifically, the problem was to devise a walk through the city that would cross each bridge once and only once, with the provisos that: the islands could only be reached by the bridges and every bridge once accessed must be crossed to its other end. The starting and ending points of the walk need not be the same.

In this sense, the first issue raised in this field is the Chinese Postman Problem (CPP), formulated in 1962 by Meigu Guan, a Chinese researcher who became one of the leading experts on mathematical programming in China.

Examples of these types of routing problems are: the cleaning of streets, the plowing of snow after a snowstorm and the collection of garbage from houses.

This project is based on the distribution of products to a specific number of customers located in a city (Chapter 7). Because of this, in the following chapter the node covering problem is described.

4.1 Terminology to be considered

In order to better understand the issues that will be described below, a brief introduction to graph theory is made in this chapter.

Thus, the routing optimization problem can be described through graph theory as follows.

A **network** (or graph) will be used to refer to an entity G (N, A) consisting of:

- A finite set N of **nodes** (N = 1,2,3,…,n). In a network problem, a number of nodes are usually specified. When it talk about nodes will be the customers, except N = 0 which is the distribution center.
- A finite set A of **edges**, which connect pairs of nodes. An edge connecting nodes "i" and "j" will be denoted as (i, j). Therefore, from now, an edge will be the vehicle travel between two clients.
    - Note that a directed edge (i, j) has associated a non-negative value representing the length from vertex "i" to "j", where can be in units of cost, distance, time, and so on.
    - We will use the notation d(i, j) to indicate the shortest length between nodes which belong to the set N of G.

A **path** on a directed network is directed, with adjacent edges leading into and away from successive nodes. This path can be indicated as sequences of adjacent nodes, e.g., S = {a, b, c,…,i,j,k}. We will say that a path is a **cycle** (or circuit) when the initial and final node match.

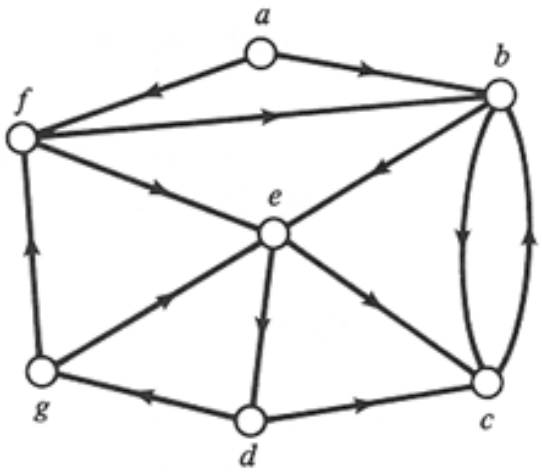

Figure 14. A directed graph. The nodes *f* and *e* are adjacent; the nodes *a* and *d* are not.

4.2 Node covering: Vehicle Routing Problem

The Vehicle Routing Problem (VRP) is the generic name given to a class of problems that should determine a number of routes for a fleet of vehicles, in order to supply a certain number geographically dispersed customers.

More simply, the vehicle routing problem answers the following generic question:

"What are the optimal routes for a fleet of vehicles to deliver goods to a certain set of customers?"

Suppose the following situation: A company has to deliver goods from its warehouse (depot), which has a set of three vehicles operated by drivers, who move on a road network in order to visit and supply all of customers.

Through the VRP, we must determine a set of routes S (one route for each vehicle that must start and finish in their own warehouse), such that all customers' requirements are satisfied. It should also ensure that the global transportation cost is minimized.

In order to plot these routes, the network is described using the following graph, where the arcs are roads, and nodes are connections between them:

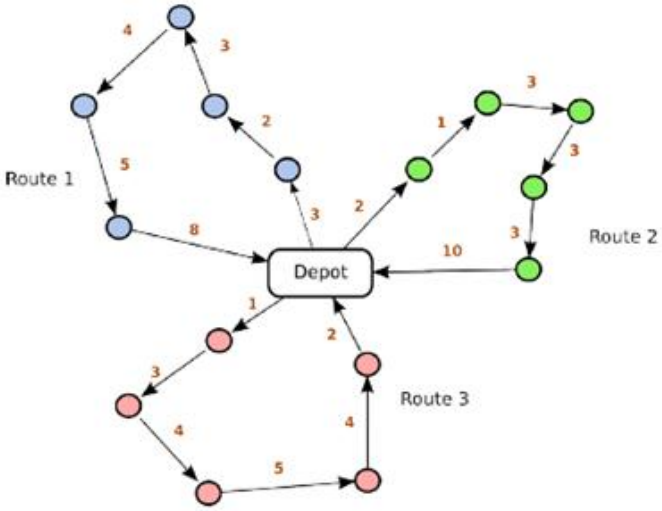

Figure 15. A typical solution of VRP with a unique depot

Note that each arc has an associated cost which is usually its length (expressed in distance), cost (money) or travel time.

As we can see, when we are designing the routes, several restrictions appear such as the characteristics of customers, warehouse and vehicles as well as different operating restrictions on routes:

- **Capacity**: Each vehicle has a capacity, Qk. It is therefore necessary that the vehicle capacity does not exceed the total demand of its route. This capacity could have several dimensions, such as weight and/or volume.
- **Demand**: There is a known demand, Qi, to be distributed throughout the city. Each customer has a demand of Qi units of some product.
- **Length**: Many times the aim is to minimize the total length travelled by all the vehicles. There could be restrictions on the maximum distances of a route because of the capacity of the vehicle's petrol deposit.
- **Time**: Clients may have restrictions on their availability. Usually these restrictions are expressed as timeslots (called time windows) in which can be supplied goods to the customer. The vehicle must visit the customer during a time window [ai,bi], ai being the earliest arrival time at customer while bi is the last arrival time.
- **Cost**: Each vehicle is associated with a fixed cost that is incurred when using it, and a variable cost proportional to the distance traveled.

- **Size of fleet vehicles**: The amount of available vehicle, K, could be an input or a decision variable. The most common objective is usually to use fewer vehicles.
- **Legal regulations**: They may impose restrictions on the maximum time that a vehicle can be parked on the loading and unloading zone, and even prohibit the passage through certain areas.

Some of these restrictions give rise to different variants of the problem:

- Problems in which no restrictions are specified are known as **Traveling Salesman Problem (TSP).** If there is more than on vehicle, the problem is known as **m-TSP**.
- **Capacitated VRP**: When only capacity constraints are present, which means each vehicle has a limited capacity.
- **VRP with time windows**: When each client has to be served within a certain time window.

In the real life, VRP problem should be solved because there are capacity constraints and time windows. However, since VRP is a difficult problem, it is interesting to study easy cases that can provide some insight into the structure of the problem. Thus, in this project the TSP problem is explained on the assumption that there is only a vehicle with unlimited capacity (m-TSP variant is also introduced). Many solutions of the TSP can easily be extended to the VRP.

4.2.1 Travelling Salesman Problem

As we have seen above, if the delivery must be made to a number of specific points (referred to customers), the routing problem that must be solved becomes a node covering one.

In this sense, the Traveling Salesman Problem, or TSP for short, was formulated in 1930 to find solution to these situations. It is a problem designed for a single salesman (vehicle) using a single origin-destination with no capacity, tour-length or time windows restrictions. Thus, it must be assumed that:

- The capacity Qk of each vehicle K is larger than the total demand of the customers.
- The drivers and customers are available at any time.

This kind of problem aims to find the minimum distance route that begins at a given node of network (distribution center), visits all the customers of a specified set of nodes on the network at least once, and returns eventually to the initial node.

The TSP is a typical combinatorial optimization problem, but despite this, are not yet known algorithms that solve it exactly. The algorithms used for resolution only provide approximations, and the optimal solution is only achievable for specific cases of the problem.

Within this combinatorial optimization of which the TSP is under study, he is listed as a NP-Hard problem, which means that the computational effort to be carried out to find an optimal solution grows exponentially with the number of nodes or vertices in the network. Therefore the number of nodes will be crucial in determining the complexity of the problem. With a larger number of nodes will be larger number of possible routes, and therefore, greater effort will be required to calculate them all.

Thereby, given N+1 nodes (the distribution center more N clients) we have to determine:

- A circuit (or cycle, if there is no symmetry) in which every N nodes must be visited once by the vehicle.
- And said circuit (or cycle) must have a minimum cost.

Thus, the number of possible routes between N+1 nodes will be equal to N!. Just having a simple network of 7 nodes, it would be necessary to calculate more than 5000 combinations, (7! = 5040). If we consider that each tour can be run in either of two directions, the number of possible routes would be N!/2.

Note that the network that interconnects these N points is completely connected. In other words, it is possible to go directly from any point to any other point without passing through any of the other points in the set, which it means that each point is visited exactly once. In addition, the network satisfies the triangular inequality for any three point i, j and k. This implies that $d(i,j) < d(i,k) + d(k,j)$.

If we wish to express the problem mathematically using the graph theory, the TSP would be to find a Hamiltonian cycle in a G network, such that the sum of costs of edges in this cycle is as small as possible.

The nature of the network will define the type of TSP that is built from it, and more specifically its cost matrix. Thus, if the cost matrix is symmetric, that is, the network graph is undirected (or nonoriented); the TSP is called Symmetric Traveling Salesman Problem (sTSP).

If the graph of the network is directed (or oriented), the cost matrix why will not necessarily be symmetrical, and in this case the Asymmetric Traveling Salesman Problem (aTSP) is defined. Like any undirected graph can be transformed into one directed (doubling the edges so that there is one in each direction), the sTSP can be seen as a special case of aTSP.

Otherwise, there is a more complex problem that depends on the number of routes, which is called multi TSP (*m*-TSP). In this case, the *m*-TSP is a problem that aims to design routes for all *m* salesmen, who all start and end at the depot, such that each client is visited exactly once and the total cost (defined in terms of distance, time, and so on) of visiting all nodes is minimized. Thus, the aim of m-TSP is to find an optimal solution, so that:

- It can decide which customer should be served by which vehicle K.
- It can determine the order in which each vehicle K should visit its customers.

4.3 Conclusion

It has described a simple model that can be used to solve simple Vehicle Routing Problems (VRP). As it has seen, when there are additional restrictions these models must be adapted. The typical restrictions are capacity and time window requirements. Consequently, there exist several variants of the problem.

The first case happens when the vehicles have limited carrying capacity of the products that must be delivered. The second occurs when the deliveries must be made within a certain time frame. In this case, the vehicle may arrive before the time window opens but the customer cannot be serviced until the time windows open. It is not allowed to arrive after the time window has closed.

Finally, when we are planning daily deliveries, it also must take into account that the drivers have customs such as having their lunch at a specific place and schedule. Such kind of restrictions can easily solved defining a customer "restaurant" with a given time window corresponding to lunchtime.

Chapter 5 Design of distribution networks

A company must decide whether transportation from a supply source will be direct to the demand point or will go through intermediate consolidation points.

The objective of this chapter is to describe each distribution option and discuss its strengths and weaknesses. It can provide the necessary information to know what network will must use in this project.

In this section, we discuss distribution network choices from the manufacturer to the end consumer. It is important to make two key decisions when designing a distribution network:

1. Will product be delivered to the costumer location or picked up from a specific site?
2. Will product flow through an intermediary?

To answer these questions, it is important to consider product characteristics as well as network requirements when deciding on the appropriate delivery network. The main requirements to consider are response time, availability and time to market:

- **Response time**: In selling products that cannot be downloaded on Internet, an e-commerce takes longer to fulfil a customer request than a retail store because of the shipping involved.
- **Product availability**: Thanks to better demand forecasts, an e-commerce leads to a better match between supply and demand.
- **Time to market**: An e-commerce can introduce new products much more quickly than a company that uses physical channels.

Given the above information, there may be many distribution networks. The main ones are described below:

- Manufacturer storage with direct shipping
- Manufacturer storage with direct shipping and in-transit merge
- Distributor storage with carrier delivery
- Distributor storage with last-mile delivery

It is now briefly describe each distribution option and discuss its strengths and weaknesses, extracted from *Supply Chain Management (Sunil Chopra).*

5.1 Manufacturer storage with direct shipping

In this option, product is shipped directly from the manufacturer to the end customer, bypassing the retailer (who takes the order and initiates the delivery request).

The retailer, if independent of the manufacturer, carries no inventories. The biggest advantage of this option is the ability to centralize inventories at the manufacturer. A manufacturer can aggregate demand across all retailers that it supplies. As a result, the supply chain is able to provide a high level of product availability with lower levels of inventory.

This distribution network is shown in Figure 16.

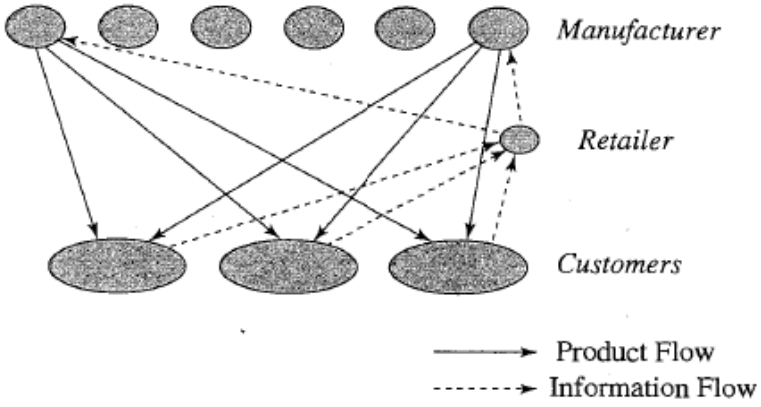

Figure 16.Manufacturer storage with direct shipping.

5.2 Manufacturer storage with direct shipping and in-transit merge

Unlike pure drop-shipping, under which each product in the order is sent directly from its manufacturer to the end customer, in-transit merge combines pieces of the order combing from different locations so that the customer gets a single delivery.

A good example is Dell. When a customer orders a PC from Dell along with a Sony monitor, the package carrier picks up the PC from the Dell factory and the monitor from the Sony factory; it then merges the two together at a hub before making a single delivery to the customer. In-transit merge allows Dell and Sony to hold all their inventories at the factory.

In most cases, transportation costs are lower than with drop-shipping because of the merge that takes place at the carrier hub before delivery to the customer, although an increase in coordination is required.

An order with products from three manufacturers thus requires only one delivery to the customer, compared to three that would be required with drop-shipping.

Overall supply chain facility and handling costs are somewhat higher than with drop-shipping.

A very sophisticated information infrastructure is needed to allow in-transit merge. In addition to information operations at the retailer, manufacturers, and the carrier must be coordinated.

Response times, product variety, availability, and time to market are similar to drop-shipping. Response times may be marginally higher because of the need to perform the merge. Customer experience is likely to be better than with drop-shipping, because the customer receives only one delivery for an order instead of many partial shipments.

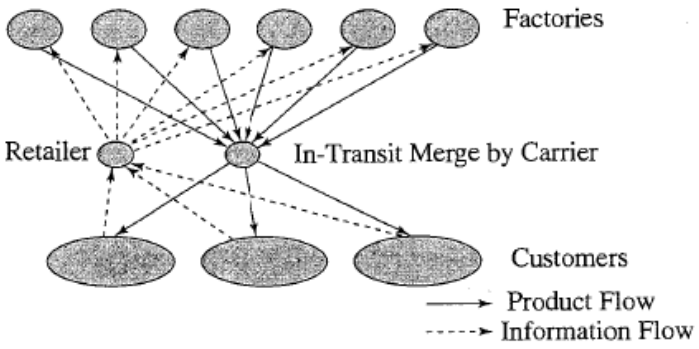

Figure 17.Manufacturer storage with direct shipping and in-transit merge.

The main advantages of in-transit merge over drop-shipping are lower transportation cost and improved customer experience. In-transit merge requires a higher demand from each manufacturer (not necessarily each product) in order to be effective.

5.3 Distributor storage with carrier delivery

Under this distribution network option, inventory is not held by manufacturers at the factories but is held by distributors/retailers in intermediate warehouses, and package carriers are used to transport products from the intermediate location to the final customer.

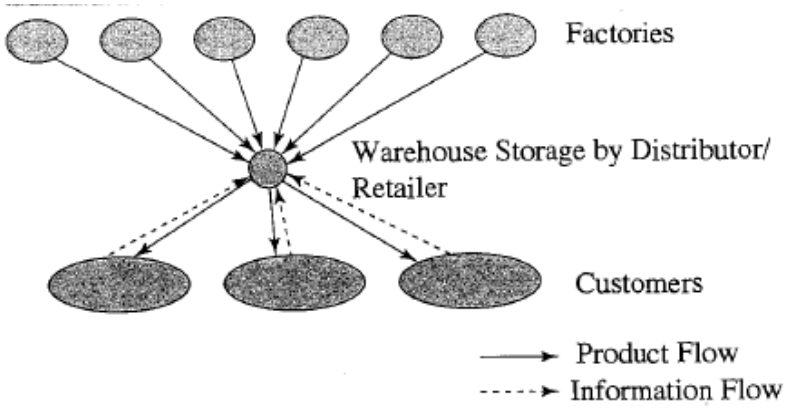

Figure 18.Distributor storage with carrier delivery.

Transportation costs are somewhat lower for distributor storage compared to manufacturer storage because an economic mode of transportation (e.g., truckloads) can be employed for inbound shipments to the warehouse, which is closer to the customer. Unlike manufacturer storage under which multiple shipments may need to go out for a single customer order with multiple items, distributor storage allows outbound orders to the customer to be bundled into a single shipment, further reducing transportation cost.

The information infrastructure needed with distributor storage is significantly less complex than that needed with manufacturer storage.

Response time under distributor storage is better than under manufacturer storage because distributor warehouse are, on average, closer to customers.

Distributor storage also makes sense when customers want delivery faster than is offered by manufacturer storage but do not need it immediately.

5.4 Distributor storage with last-mile delivery

Last-mile delivery refers to the distributor/retailer delivering the product to the customer's home instead of using a package carrier. Unlike package carrier delivery, last-mile delivery requires the distributor warehouse to be much closer to the customer.

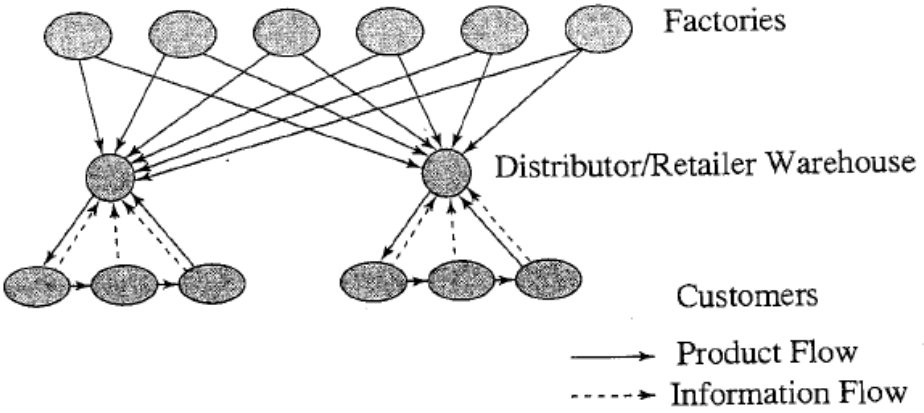

Figure 19.Distributor storage with last-mile delivery.

Distributor storage with last-mile delivery requires higher levels of inventory than the other options because it has a lower level of aggregation.

Among all the distribution networks, transportation costs are highest for last-mile delivery.

Delivery costs (including transportation and processing) can be about 30€ to 40€ per home delivery in the grocery industry.

The information infrastructure with last-mile delivery is similar to that for distributor storage with package carrier delivery. However, it requires the additional capability of scheduling deliveries.

PART II. BUSINESS CASE

Chapter 6 Introduction

In this section the theory learnt so far will be applied to a newly created company. After having found a niche in the market, it has been decided to create an online shop. This is due to the fact that more and more people use the internet to do shopping, in order to buy anything from electronic items to food products.

Food shopping is a task which takes a lot of time and is generally unpleasant. This enterprise allows the client to shop from home at every moment of the day and with a home delivery, thereby eliminating a journey to the supermarket. It is a great advantage in the urban areas like Barcelona, where the consumer has to walk long distances and carry the purchase back home.

It is about answering questions about how the company must structure itself, for instance:

- What are the advantages of selling food products via the Internet?
- What are the differences compared to the traditional trade?
- Must the company store all the products that it sells? Is it appropriate to use outsourcing?
- Where must the distribution centre be located?
- How will the merchandise be distributed in the city where the company operates?

It must be mentioned that via the current business case it is not intended to quantify the needed resources like the number of delivery vehicles or the distribution centre capacity. The aim is to explain all these aspects that must be taken in account at the moment of designing the supply chain of the supermarket, and how these influence the development of entrepreneurial activity.

Chapter 7 Business model

Thanks to the available technologies, it is possible to create an online platform in which the client explores, chooses and selects products in total comfort. An interactive shopping list is available at every moment. Thus, the client saves time and displacements to the traditional shops. This way, factors that determine the online shopping are the rapidity, the facility, the planning, the shipping costs, the refund and the collection. This also eliminates the need for expensive storefronts.

With the aim of competing against the supermarkets which already exist, the company buys directly from the manufacturer and stores the products in anticipation of the clients' demands. The company offers a catalogue of each type of products, including drugstore items and personal hygiene, reasonable quality at an affordable price.

Items that are commercialized can be broadly classified in:

- Frozen products like ice cream, frozen food and ice cubes.
- Precooked food and fast food.
- Fresh products like sandwiches, milk and juices.
- Canned products and condiments.
- Energy drinks, nutritional drinks, alcoholic beverages, beers and wine.
- Hygiene items such as soap and detergents.

In addition, home delivery is guaranteed at the earliest possible date tailored to the individual client's needs. That delivery will be between 8:00 am and 11:00pm, from Monday to Saturday (Chapter 8.3). The client will plan and conclude the delivery during the following days after the order closure. It should be noted that the vehicles have a cooling system thereby ensuring their arrival in perfect conditions for consumption. As we will see further, the option of using external distribution companies such SEUR or FedEx must be addressed.

To conclude, mentioning the fact that the form of payment is facilitated, the client has the option to choose between the online forms, PayPal or via the credit card at the point of the delivery.

7.1 Field of study

Initially the company will operate in the city of Barcelona thereby serving all of the urban areas including l'Hospitalet de LLobregat, Cornellà de Llobregat, Esplugues de Lllobregat and Sant Adrià de Besòs municipalities.

Barcelona City has a surface area of 99.07 km^2 and is made up of 10 districts with social characteristic, demographics and economies that are totally different between themselves. , more specifically, the current territorial division consists of:

- 10 municipal districts. It is meant by district the biggest territorial unit in the municipality of Barcelona.
- 73 districts. Delimitation from the urban and social point of view, like the territorial framework for the development of urban activities and the provision of specific levels of equipment and municipal services.

With the aim of studying the implementation of the home delivery services, the city must be divided into small studying areas. For this, it is essential to analyse some aspects such as each district surface, its population, the number of houses, as well as the monthly household income.

This way, the study area must fulfil the following requirements:

- Each of them represents an urban continuum with social and economic uniforms.
- Its road infrastructure must be homogeneous.
- Districts can be grouped together in Barcelona according to their postcode.

The main characteristics of municipal districts are shown below:

	AREA (km^2)	POPULATION
CIUTAT VELLA	4,31	100.115
EIXAMPLE	7,47	263.558
SANTS-MONTJUIC	20,87	180.757
LES CORTS	5,98	81.530
SARRIÀ-SANT GERVASI	20,01	146.834
GRÀCIA	4,15	120.401
HORTA-GUINARDÓ	11,92	166.559
NOU BARRIS	8	164.648
SANT ANDREU	6,53	146.494
SANT MARTÍ	9,83	233.659
TOTAL	99,07	1.604.555

Table 7. Population of Barcelona (2015)

As can be seen, the city has a high population density of 16.000 people per square kilometers. This makes Barcelona one of Europe's most densely populated cities. By far the most densely populated area in the city is Eixample, with 36,000 people per square kilometre.

7.2 Activity: urban merchandise distribution in Barcelona

As has already been mentioned, the company has the principal activity of distribution of food products in Barcelona city. Orders are placed through Internet, but deliveries are made at the customer's home. For this reason a complicated problem is presented: distribution in an urban environment. Cities such as Barcelona need to carry out good distribution operations that coexist with the rest of urban functions.

Urban distribution is creates important problems of a special nature (territory occupation), functional (services operation), environmental (pollution and urban degradation) and road safety.

The distribution in Barcelona, like the final part of the supply chain distribution, is exercised in a characterized scenario for the following general restrictions: the narrowness of the streets, special traffic regulations, shortage of logistical equipment and the confluence with the foot traffic and other urban services. Therefore, these operations that are developed by the company are seen as completely conditioned by the urban structure.

Broadly, the principal merchandise shortage problems in Barcelona are the circulation, which is characterized as being slow due to high levels of road congestion and limited parking areas. Currently, parcel companies can park in identi-

fied places such as the urban distribution of goods (DUM), intended for loading and the unloading. In such places, the maximum parking time is 30 minutes and once this time has elapsed, the user must leave the place for others users who might take advantage of the scarce and limited commodity of parking in Barcelona.

Once we arrive at this point, it is necessary to define the road typology of Barcelona as well as circulation facility according to activity hours, two aspects that determine the distribution of goods.

Road Structure:

Barcelona is divided by a diversity of road structures that range from an orthogonal net with alternated ways of circulation (as is the case of the Eixample district), to old towns with altered street directions (such as Ciutat Vella, Gràcia and Sarrià).

Therefore in Barcelona city an urban structure diversity can be found:

- **Old town:** This is the oldest part of the city. It is characterized by its low accessibility for transport vehicles of goods since it has narrow streets and footpaths. It has a great number of shops and catering establishments.
- **Centre:** It is the main backbone of the city. This is the zone that has the largest number of historic and administrative buildings. It is characterized by its streets with a calm traffic (zones 30) and by its great number of business premises. There are important restrictions on the traffic and on parking of the vehicles.
- **Residential areas:** These are the ones that occupy most space and its function consists of accommodating inhabitants. As has been mentioned in the previous paragraph, differences between some districts and others have been seen on the basis of the socio-economic level. It is about accessible zones for transport vehicles of goods.

Figure 20. Old town of Barcelona

Figure 21. Eixample district

By applying the routing models that have been explained in the previous paragraphs, in each of these zones random points should be chosen and the real distances for different combination for each of them should be calculated. These distances should respect addresses and turns that are allowed in the street that are in conformity with the zone.

Periods of activity:

Another important aspect is the traffic behaviour in the city. The largest number of loading and unloading operations in Barcelona city is between the time slot of 9:00 and 14.00. The second period of peak times is from 16:00 to 19:00.

Due to the density of the city, the activity concentration at some peak times and the limited zones for parking leads to a high number of vehicles being illegally parked in order to be as close as possible to their destination That is to say, given the shortage of these types of places , the delivery man is forced to double park or to park on the curb which in turn creates additional problem with traffic.

Despite this, it should be mentioned that expansions are currently taking place in Barcelona which is enabling the creation of new parking zones for loading and unloading. In addition, this raises the question of new measures to encourage the traffic transfer of off-peak periods (it is a reference to the hours of the day that have less traffic).

To conclude, mentioning that the delivery speed is affected by congestion, since it occurs in some time zones in which the demand is at its highest. By the term congestion, we understand the delay produced in moving at a reduced speed than that which is permitted. This speed of reference depends on the coordination of the traffic lights, the current legislation on maximum speeds and road safety, and of the flow of vehicles.

Figure 22. Congestion in Barcelona's streets

7.3 Competition

It would be interesting to undertake a study on the volume quotas of businesses owned by the major companies within the sector with the aim of understanding the current market.

In the past year, distribution groups of the Grand Consumo sector that have increased the most in terms of market share are DIA and Lidl. So, DIA Group is positioned as the second group in Spain with a market share of 8.7%. Lidl, for its part, is the chain that attracts more buyers and it corresponds to 3.5% of the market.
Mercadona, which continues to lead the distribution sector with 22%, is still increasing. This is the same for Carrefour which goes from 8.3% to 8.5%. Eroski Group has fallen by a tenth in the past year by having 6.3% of market share. To conclude, Auchan Group maintains 3.8%.

As a whole, in Spain these 6 principal groups of distribution concentrate 53.7% of the food market, drugstore and perfumery. It should be mentioned that the same market share proportion is extrapolated to that of the autonomous communities. So, in Catalonia Mercadona Group continues to be the most powerful chain.

Then, a graphic of the supermarket market share in Spain is shown concerning the past two years. (2014 and 2015):

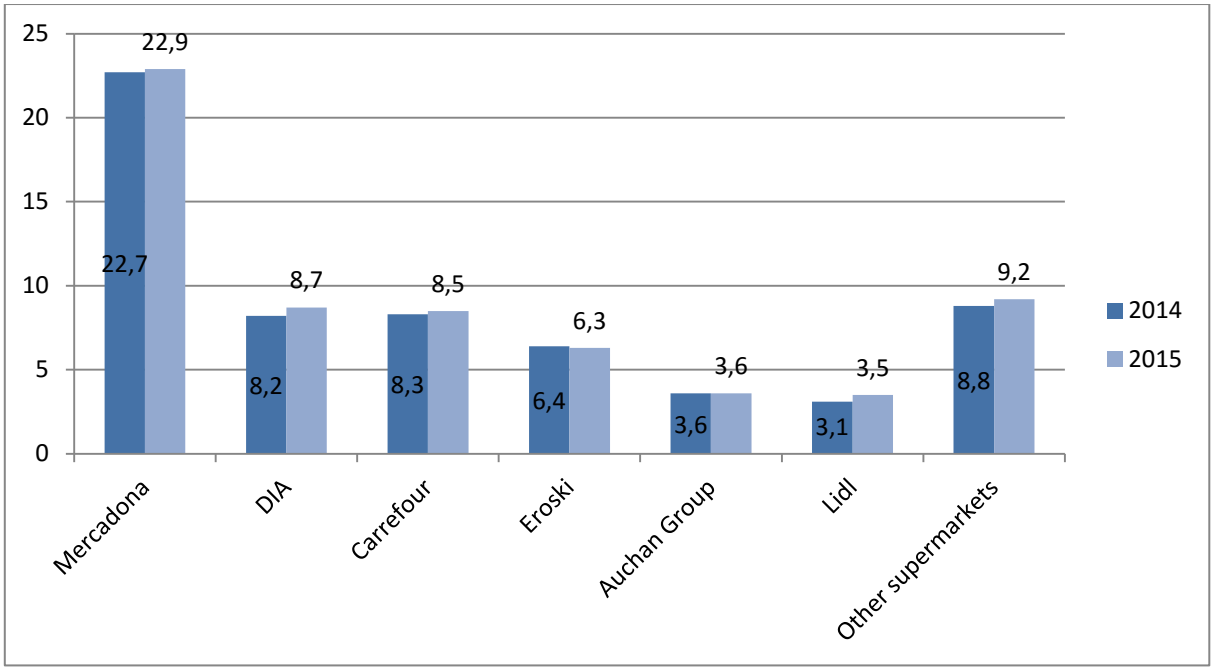

Figure 23. Supermarket market share in Spain

As it has been commented previously, e-commerce is gaining supporters with a consequence of a change in habits and increased access to new technologies.

To summarize, currently e-commerce represents approximately 1% of food spending, quantifying around 600 million every year. Of this, 85% correspond to what has been realized by the big traditional supply chains. Here we refer to Mercadona, Carrefour, Grupo Eroski (including Caprabo), Auchan (Alcampo and Sabeco) El Corte Inglés Group and DIA.

Concerning the exclusive online distributors, where its competitive advantages are its fresh food; companies like La Depensa or Ulabox. These two companies have an accelerated growth even though they are not currently market representatives. In addition it should be noted that the entry in the sector of AmazonFresh.

To enter more in detail, we will briefly comment on these 3 companies that are competing directly with the development in this project:

- **La Despensa**: offers up to 7,000 products, including a good proportion of fresh products. The company has become the first exclusively 'online' supermarket in Spain with over 100,000 customers.

- **Ulabox** offers up to 13,000 products to consumers countrywide and promises 24 hour deliveries. The company has strong logistics and distribution systems in big cities like Madrid or Barcelona that allow it to deliver orders in up to two hours.

- **AmazonFresh** is a subsidiary of the Amazon.com. It revived the business model of ordering groceries online for home delivery. Items ordered through AmazonFresh are available for home delivery on the same day or the next day, depending on the time of the order and the availability of trucks.

Figure 24. AmazonFresh warehouse

7.4 Demand forecasting

Once the market environment where entrepreneurial project operates is delimited, the future demand in this market must be known. This demand will be useful to determinate some entrepreneurial decisions that we will make in the future chapters.

It is necessary to understand the difference between sales and demand. On the one hand, sales represent how much is actually sold from the business. On the other hand, demand shows the need fot the products and services on the market. This differentiation is important because there may be two situations:

- Demand cannot be satisfied: This means that the business capacity cannot satisfy current demand on the market for certain products.

- Sales are less than demand: It is a clear signal that competitors satisfy the market demand. This also means capacity is bigger than real market needs.

It should be clarified that we understand the demand analysis, the quantitative identification of the market size previsions as the purpose of the customer service. That is to say, its purpose is to get to know with precision what the demand size is, what is the potential clients purchasing power among things like the consumer behaviour. It should be noted that this demand analysis must also consider plausible evolution scenarios in a medium term time horizon, that is to say, of two or three years.

In this regard, the demand will be the volume that our service will reach in the established timeframe. This demand will be calculated from the estimated number of buyers to those who are assigned an individual consumption rate.

In order to estimate this demand the necessary information should be collected and the existing historical data concerning the geographical scope delimited by the company should be analysed. The prevision will establish the future behaviour, based on the information of the past.

Thanks to the estimated demand, the storage capacity can be identified. As expected, capacity is the most important factor in the design of a storage area, and therefore is one of the most critical decisions that the warehouse management must deal with. Once the storage size is estimated, this size will become a restriction on operations that are executed therein.

7.4.1 Main demand characteristics

In the graphic below are shown some of the characteristics that must be taken into account:

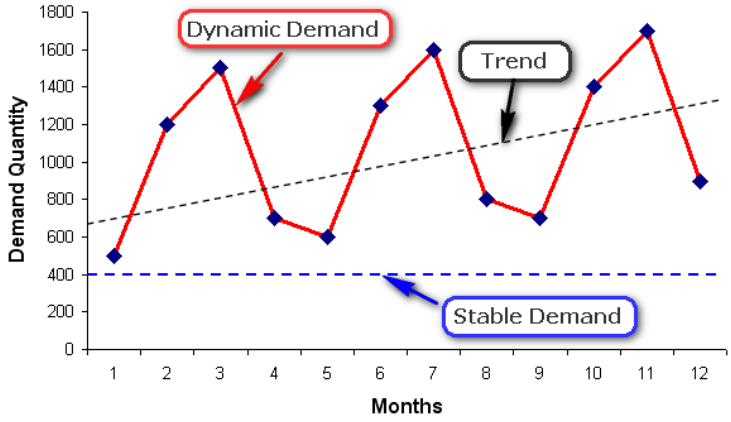

Figure 25. Demand from historical data

The graphic shows the quantity of demand from historical data on a time scale. It can be seen a pattern that in some months demand is increasing and in another months decrease because of trend, cycle and seasonality.

Another characteristic of demand is that it can be stable or dynamic. A stable demand exists when there are not changes in the demand over time. On the other hand, dynamic demans is when the shape is changed over time.

If the demand is stable is much easier to forecast it. Otherwise, if the demand is dynamic there will be much more work to predict.

7.4.2 Demand assumption

Since the aim of the current project is not to quantify the future demand (statistical techniques or mathematical tools are required) this will be separated from the information of the current competition in the food sector that has been obtained in the previous paragraph.

So, the collected data in relation to the food sector gives us an idea of the current demand of this type of products. In addition, it should be noted that when it comes to electronic commerce, and due to the fact that the Business to Consumer is characterized by the receipt of the order at the client's house, it is expected that the demand distribution is proportional to computer equipment and access to the internet which the homes in the study area have.
In this regard, according to the Statistical Institute of Catalonia (IDESCAT), the TIC equipment of Catalan homes is mainly in relation to the family income, the level of education and the number and the age of the members of the family. (As has been explained in Chapter 2.1).

On a practical level, the company will have a personalised website which provides demand forecasts visualisations based on the shopping that already has been done, as well as other data of interest concerning the clients. This will help the suppliers to have a better idea of the demand and to improve their production programming.

Chapter 8 Supply Chain Management

The company distribution system is entirely flexible in order to deliver within time frames established by the clients. Fresh products and fast-food replenishment cycle will last less than 24 hours. Thus, a purchase order of a pre-prepared plate of food can be delivered before lunch time.

Generally, when an online order is received, it is transmitted directly both to the supplier and the distribution centre of the company itself. Once the order is received, the supplier sends the required products to the distribution centre. The distribution centre receives items from different suppliers and therefore these items must be selected to be packed in the same order and sent to destination. This picking-packing task must be done every day for each order issued. As it can see, the company's success is based on a correct exchange of information. This is why the company will provide real time data of the state of the order.

In order to offer this service of distribution efficiently, the company must invest strongly in the areas of transport and infrastructure that make the merchandise and information flow easier.

In this way, a characterised supply chain must be designed in order to have distribution centre close to the centres of production with the aim of facilitating the replenishment at an effective cost and, and at the same time, close to the clients. This replenishment will allow the company to supply customers more effectively than the competition.

In the following sections, a detail of each element that must be taken into account will be explained for the entrepreneurial project to be viable. As we will see later, one of the main aspects to be treated will be the externalisation of logistical activities.

8.1 The supply chain

To better understand the supply chain of the company a scheme is shown, in which the arrows indicate the direction of flow of products.

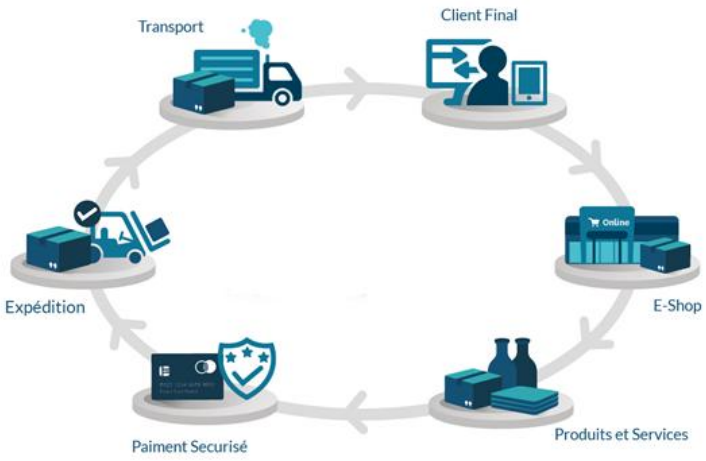

Figure 26. The company's supply chain

In order to explain the supply chain, it is considered that a customer intends to make an online purchase through the company. As is evident, the supply chain begins on the need for the customer to purchase these items. The next phase of this chain is the web page which the customer can purchase. Once the client consults the necessary information on price, product variety and availability of these, he decides to make the following order:

- A package of pasta (1kg)
- A pack of yogurts (6u)

Unlike traditional supermarkets, the website guides users based on their preferences and what they buy. In this sense, as the customer has bought example pasta, it is suggested the possibility of buying Parmesan cheese as a supplement. Definetely, it suggest products that match customer's preferences.

At the time the order is complete, the customer proceeds to pay for the selected items. It is noteworthy that the customer can enter the page as many times as he wants to check the status of his purchase. From this time the purchase order is issued, and picking-packing process begins in the distribution center.

The packaging is crucial to prevent food waste and guarantee the high-quality standards. It is also important optimize its weight and volume.

The distribution center keeps the inventory needed to supply all orders. The stock comes from the manufacturers. Manufacturing comprises all the processes that are necessary to transform perishable raw materials into food products for consumers. Continuing the example, the distribution center has been previously supplied by:

- Pastas Gallo in the case of pasta
- Danone in the case of yogurts

If we consider the case of Pastas Gallo, we can see how the product manufacturing has a relatively constant demand, which is a low uncertainty. This makes the offer quite predictable. Since this facility prediction and in order that the final product price is not high, the company Pastas Gallo design an efficient supply chain based on cost reduction. This efficiency has a positive impact on the later ones, such as the sale in the supermarket phases.

As it can see, our supply chain includes the following stages connected each other:

- **Manufacturer**: Company that transforms raw material into finished goods on a large scale. These finished goods are sold to retailers, who then sell them to consumers. Examples of major manufacturers in the grocery industry include Procter & Gamble, Pepsico, Unilever, Danone, Pastas Gallo and Nestlé.

- **Distributor**: It is the company responsible for collecting all products from manufacturers and sends them to the end customer. Distributors can work alone or outsource their operations using delivery companies.

- **Delivery Company**: Once a payment has been accepted by retailer, the goods can be delivered through a retail courier such as FedEx, DHL or SEUR.

- **Customer**: Having relationships with our customers is an important part of growing a successful business. Note that needs and expectations are not the same for all customers. Age, gender, experience and culture are all important factors. At any moment, an unhappy customer can share their opinion through social media and the web and negatively affect our business.

The company that we are designing is a supermarket that operates over the Internet and sends the orders to customers through shipping companies. This means that the online supermarket is in the distributor stage.

In summary, the following diagram shows the type of relationship that exists at different stages. It is about distributor storage with Delivery Company to transport grocery items to the final customers:

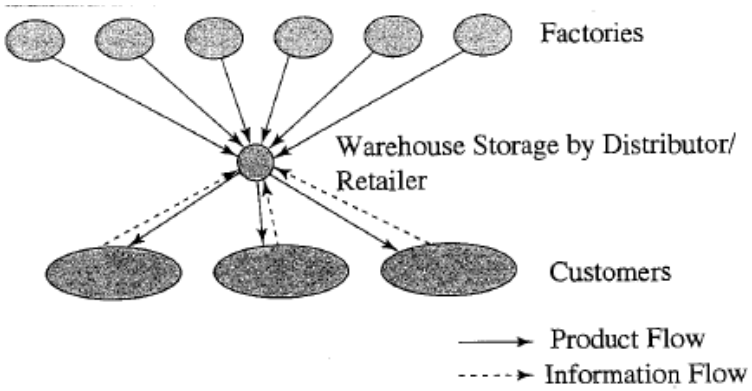

Figure 27. Manufacturer storage with direct shipping and in-transit merge

Transfer of funds throughout the supply chain:

Supply chains encompass the end-to-end flow of information, products, and money. Throughout the supply chain we have explained that certain transfers of funds are given. As has already seen, the online store provides the product and the price and the necessary availability information.

Continuing with the same example, the customer buys the package of pasta for 0.95 € and 2.15 € for the pack of yogurts. That is, the customer transfers money to the supermarket, which represents business income.

The difference between 3.1 € of the total purchase and the sum of all costs of the supply represents the profit. This benefit has to distribute through all stages of the supply chain and intermediaries.

8.2 Developing supply chain strategies

Strategies define how the supply chain should operate in order to achieve competitiveness. In this context, the proper alignment of the supply chain with business strategies is essential to ensure a high level of business performance.

Generally, supply chain strategy evaluates the cost-benefit trade-offs of operational issues. Thereby, these strategies constitute the decisions on operations throughout the supply chain to meet specific objectives. Definitely, strategies focus on reduce operational costs and maximizing efficiencies.

Another reason for having supply chain strategies is to determine how the company will work with its supply chain partners such as suppliers and customers. As the marketplace is very competitive, it is fundamental to reinforce relationships.

The first step is to clearly understand how the online supermarket chooses to compete. As has already been mentioned, the business strategy is to be the low cost distributor. Then, the supply chain strategies should support this.

The next step is to develop a strategic plan which should include distribution center location, inventory management, development considerations and possibility of outsourcing.

Supply chain decision making:

This business case provides a visual framework for supply chain decision making:

The online supermarket has to compete with traditional supermarket in terms of cost. It is necessary to clarify that traditional supermarkets bring products to the consumers with very low costs. In this sense, the business goal is to be a low-cost retailer for a wide variety of grocery products.

The strategies that have to be considered take into account the efficiency but also maintain an adequate level of responsiveness. In order to achieve this supply chain performance, the online supermarket will consider these key aspects effectively:

- Choice of distribution center location
- Collaboration with partners
- Supervision and control of the ordering and storage
- Management of own resources and processes used to deliver products from distribution center to the point of consumption.

The company will take into account all these aspect to achieve the right balance between responsiveness and efficiency so that its competitive strategy and supply chain strategy are in harmony.

As will be seen in the followings chapters, the online supermarket can have its own transportation fleet to keep responsiveness high. But this could increase transportation cost and the outsourcing will be considered.

Another thing that will be taken into account is the product availability through an inventory management. The entire supply chain focuses on meeting this demand in an efficient manner.

In the case of facilities, the company will use a centrally located distribution center within its network in order to increase efficiency. The company will also invest in information technology to improve responsiveness throughout the supply chain. Thus, the company sends demand information to suppliers who manufacture only what is being demanded.

8.2.1 Distribution center

The distribution center can accomplish two needs, the demand of the customer and the supply from the manufacturers. The location of distribution centers is a key element in the design of a company's supply chain.

When a company is looking to set up a distribution center it can use a number of site location theories to help determine the optimum physical location.

Companies can gain economies of scale when products are stored in only one warehouse because this centralization increases efficiency even though this practice reduces responsiveness.

Alternatively, if the objective is locating products close to customers in order to get more responsiveness, this decision increases the number of warehouses needed and, consequently, reduces efficiency.

Depending on various factors (structure of the company, demand and scope) the optimal number of storage facilities to be considered is one. Now it must use a method for solving the problem of facility location. In general terms, the problem is to give a hypothetic demand (material flow) and distribution costs, and locate the different nodes of a distribution network.

Mathematical analysis takes into account very few factors, primarily distance from other locations, and therefore transportation costs. In the end, most methods are based on minimizing the sum of the costs of transporting goods in the region of influence considered.

Location:

There are several analytical methods in order to find the optimal geographic location where the distribution center should be located. The most widely used is called "Center of Gravity Method" and it tries to find a location that minimizes the distance from other locations. For example, it minimizes the distance between a warehouse and customers or suppliers.

The approach takes the transportation costs as its primary issue. The selected location would likely be situated in an area where the transport costs to each of the sites are lowest.

This project just takes into account the distances between the warehouse and customers. Thus, the steps to follow are:

- Locate the main points of demand in a coordinate grid. Place the grid on an ordinary map.
- The relative distances must be noted.

Then, it has to use the following equations:

$$C_x = \frac{\sum_{i=1}^{n} d_{ix} * V_i}{\sum_{i=1}^{n} V_i} \qquad C_y = \frac{\sum_{i=1}^{n} d_{iy} * V_i}{\sum_{i=1}^{n} V_i}$$

Where,

- D_{ix} X coordinate of the existing location
- D_{iy} Y coordinate of the existing location
- V_i The volume of products moved to or from the i location

The aim is to calculate the X and Y coordinates using these equations where C_x is the horizontal axis coordinate and C_y is the vertical axis coordinate for the distribution center. Once it has obtained the X and Y coordinates, it must place that optimum location on the map.

Summary:

As the company operates in Barcelona, the optimum place chosen will be in a residential area. In the case of the city of Barcelona it is impossible to locate this type of facilities.

In Barcelona there are specially areas that have been designed for industrial buildings (manufacturing and warehousing).

It must determine exactly the industrial zone where to locate the distribution center. In order to get the best location, the following points are considered:

- Availability of industrial land
- Price of industrial land
- Accessibility and proximity to the main road network

Thus, the location will be in El Prat de Llobregat, in an area called “Zona de Actividades Logísticas ZAL-Prat”. This location provides ground logistics warehouses in an intermodal environment with maritime connection, railway connection and direct connection with the motorway network. Thanks to the strategic position in the Port of Barcelona and its intermodality, ZAL-Prat is privileged distribution center to supply the market of Barcelona.

Figure 28. The warehouse location in El Prat de Llobregat.

Figure 29. The warehouse location in El Prat de Llobregat.

8.2.2 Inventory management

Inventory management is an important contributing factor in the overall performance of the company. An inventory system is the set of policies that monitor levels of inventory and determine what levels should be maintained and when stock should be replenished. In the case of distribution companies, inventory is classified as in-transit, meaning that it is being moved in the whole system. In other words, inventory management answers the following questions:

- How much should I order?
- How often should I place each order?

The overall objective of this effort is to achieve effectiveness and efficiency. From the point of view of effectiveness, it is to make the product available when it is needed, with the right quality, the quantity required and at the right time. Efficiency aims to get the lowest cost possible of the resources used to carry out various activities to achieve the first objective.

When a company wants to take action on inventory management, it has to decide whether the company seeks efficiency in its operations or responsiveness. If a company requires a very high level of **responsiveness**, it can achieve this responsiveness by locating large amounts of inventory close to its customer. Conversely, a company can also use inventory to become more **efficient** by reducing inventory through centralized stocking.

In this business case, the competitive strategy is to achieve a high level of responsiveness and provide prompt service. In order to supply as quickly as possible to customers, high inventory levels will be used in the distribution center. The company will store a large quantity and variety of products to ensure a high level of availability. This availability of products, along with the location of the distribution center (explained in the previous chapter), will enable the distribution of products as fast as possible.

Other reasons to hold inventory in the distribution center are:

- The supermarket will stock up their inventories to meet unexpected demands.
- It is important that the distribution center has inventories at hand to smoothing seasonal demands.
- Taking advantage of price discounts. If we purchase goods from the manufacturers, we usually get price discounts if we buy in bigger bulks.
- Hedging against price increase. The supermarket will hold inventory to avoid from the ever fluctuating market price of inventories.

In order to maintain the same level of response but trying to lower inventory costs, **Cross-Docking** will be used. Cross-Docking is a distribution method in which the goods flow in an unbroken sequence from receiving to shipping (dispatching), thus eliminating storage. Cross-docking is just one strategy that can be implemented to help achieve a competitive advantage. Implemented appropriately and in the right conditions, Cross-Docking can provide significant improvements in efficiency and handling times.

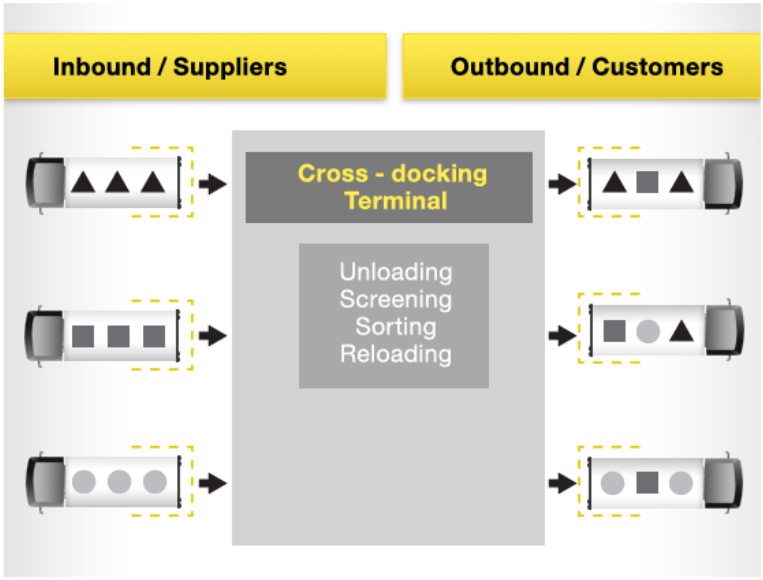

Figure 30. Cross-docking facility.

At cross-docking facilities, inbound trucks from suppliers are unloaded; the product is broken into smaller lots, and is quickly loaded onto outbound trucks. Thus, products ready for transportation to particular customers can become a faster and more efficient process through cross docking.

This competitive strategy is based in high responsiveness requirements. It is possible because customers are willing to pay a premium (Chapter 8.3) to have the products they want when they want them. Although the company incurred higher costs because of their large inventory, these costs will be absorbed thanks to the additional cost of premium service.

The last important issue to consider is the classification of products stored in the warehouse. Stocks are usually classified as follows:

- According to their **characteristics**: The main difference between perishables and non-perishables products is the shelf life. The shelf life of a product is measured in days, counting from the day it is produced until the product become unacceptable for consumption or obsolete.

    - **Perishables**: Are items with a short shelf life, less than or equal to 30 days. It includes meat, fish, milk, eggs, fruits and vegetables. All cooked foods are also considered perishable foods. To store these foods for any length of time, perishable foods need to be held at refrigerator.
    - **Non-perishables**: Non-perishable foods have a long shelf life and don't require refrigeration. Foods such as sugar, pasta, spices and canned goods do not spoil unless they are handled carelessly.

    There is no exact method to determine how long a food will maintain quality and be safe to eat, because many conditions affect quality. The life of foods is affected by the freshness of the food, temperature at which it was held before purchase, humidity level in the warehouse and type of packaging the food.

- According to **rotation**: In order to be more efficient, it must take into account the correct storage of the goods. Stock rotation involves displaying older items for sale more prominently than items that were recently acquired. The idea behind this type of rotating process is to move older products out the door in order to make room for other and newer ones. Thus, the products are stored depending on **high rotation** (inventory moving within standard margins), **low rotation** (products with little movement) and **obsolete inventory** (those likely to be unusable over time).

Summary:

Companies must keep a careful rein on their inventories. Having too much inventory or not having enough stock is considered primary direct causes of business failures. Thus, inventory management is the science of managing to have the *right product*, at the *right time* and *place*, in exactly the *right amount*, at the *best possible price*. Consequently, effective inventory management allows a distributor to meet its customers' expectations of product availability.

As has already been mentioned, the online supermarket has different products, each having different logistics characteristics and therefore need different inventory control rules. The main difference is between perishables and non-perishables. As an example, dairy fresh items need short lead times through Cross-Docking processes at the distribution center.

In conclusion, it is important that the online supermarket manages his inventory in order to get different benefits such as improvement of customer service, reduction of inventory investment and increase productivity.

8.2.3 Transport and distribution management

In today's increasingly competitive markets, companies needs to be more flexible when responding to customers demands, especially when it involves the distribution of grocery products.

The management of distribution aims to achieve the most efficient delivery to customers. Distribution service performance directly impacts customer satisfaction, delivery expenses impact revenue and driver labor and carrier costs impact the income statement. The main objective of this business case is to provide quality distribution at competitive rates.

There are many metrics that influence supply chain performance in terms of transportation. It is therefore interesting to track the most important:

- Average inbound transportation cost. It is useful to separate this cost by supplier.
- Average inbound transportation per shipment. This metric identifies opportunities for greater economies of scale in inbound transportation.
- Average outbound transportation cost. It is useful to separate this metric by customer.
- Average outbound transportation per shipment. This metric identifies opportunities for greater economies of scale in outbound transportation.
- Fraction transported by fleet vehicles. This metric can be used to estimate if certain vehicles are underutilized or overused.

Among all modes of transportation, the company that we are studying will use land transportation through delivery vans. The great advantages of this type of transportation service are its ability to provide the door-to-door service, frequency, availability, size of shipments and speed. Distribution of parcels by vans requires the use of optimized route planning and monitoring in order to minimize the number of vans needed and the total mileage without missing the pickup and delivery time windows agreed with the customers.

As has already been mentioned, the competitive strategy targets a customer who demands a very high level of responsiveness, and many customers are willing to pay for this responsiveness. Then, the online supermarket will use transportation for making the supply chain more responsive. Note that faster transportation allows a supply chain to be more responsive but reduces its efficiency.

Despite this, the company will use transportation outsourced (Chapter 8.4) to lower the cost of the product while maintaining the level of responsiveness. The reason is because there are another customers whose main decision criterion is price.

Fleet vehicles:

Fleet management is the function that oversees and coordinates transport. To maximize performance, the company needs to make sure that each trip is executed by following the best possible route. Effective fleet management aims at minimizing overall costs. Hereby, it is important to determine the optimum transport fleet requirements, whether for an in house or outsourced fleet. As will be seen in Chapter 8.4, urban distribution will be outsourced. Despite this, in this section the requirements are explained as if the company had its own fleet.

The company needs a fleet of vehicles for distribution of goods, with their specific staff. In order to determine the fleet, it should take into account aspects such as the number of vehicles and the ability of each of them.

Identification of fleet needs vary depending on the level of emergency, the kind of product to be transported, and the area of operation (Barcelona). Different products in food industry need special transport conditions. For example; transport of meat and milk products needs refrigerator vans.

Thus, vehicles used will have the following characteristics:

- The vehicles capacity ranges from a minimum depending on real demand, up to a maximum depending on the maximum weight authorized by the administration (3.500kg maximum weight in the case of Barcelona).
- Equipped with fridge for fresh products (2°C - 6°C) and cold storage for frozen products (-20°C)

Figure 31. The kind of vehicles used to deliver products

To optimize the distribution performance, the company is focusing on increasing vehicle utilization, reducing empty transport journeys and constantly reviewing its distribution networks. Managing this fleet requires being able to react quickly and efficiently when the plan cannot be met, for instance when traffic or road conditions have changed. Because of this, it requires permanent and effective communication with drivers to communicate any change in the plan and keep track of the execution of each shipment.

As has already mentioned, in order to increase productivity, the company needs to increase its vehicles utilization. Delivery vans that travel empty or with limited loads are inefficient and costly, so it is necessary to make an effort to optimize vehicle capacity utilization. Although it should be noted that the maximum load of a van is limited by the maximum weight authorized.

In this sense, it is important to cooperate with manufacturers on the use of delivery vehicles to avoid vans being empty. One of the improvements is the reduction of delayed transportation between manufacturers and our distribution center.

Vehicle tracking device:

When the driver is unloading uses his on-board computer to report which shipment is being unloaded. At the same time, the on-board computer automatically transmits the vehicle's GPS position. A digital map enables to see exactly where the vans are located, which shipments have already been unloaded and which remain to be unloaded.

With this device, the company can offer a service which puts the customers in charge of their shipment, enabling them to decide when the parcel is to be delivered. This tracking offers us that we can provide parcels with a one hour delivery window, notified by SMS and email to the customers, so they don't have to wait in all day. Through the website, the customers can check out the current statuses of their parcels in real-time and be able to track as the drivers make their way to the delivery addresses.

Further, GPS tracking provides metrics such as vehicle speed, engine performance and driver behavior.

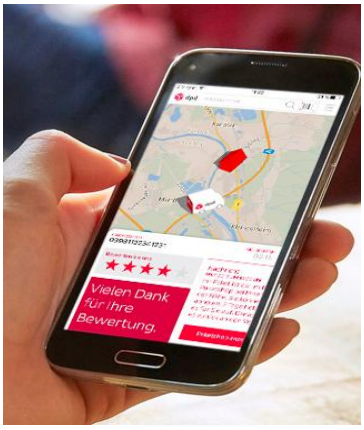

Figure 32. GPS tracking

Decision of outsourcing:

The distribution may be based on partnerships with third-party logistics providers because they can help us improve the efficiency of our network. The online supermarket is therefore able to offer significantly lower than their brick and mortar competition prices.

The nature of the outsourcing contract is dependent if:

- An external company is contracted to supply and manage the fleet
- An external company supplies the vehicles but the management remains with the online supermarket
- The vehicles are owned by the online supermarket and an external company undertakes the management of the fleet

The chosen option depends on the company based in sourcing policies and operational needs.

Relationship with manufacturers:

Given the scheme in Chapter 3.1, which explains the relationships between all stages, it is important to note that the inbound transportation from manufacturers to our distribution center is done by them. Thus, this cost of inbound transportation, despite being part of the same supply chain, it is absorbed directly by the manufacturers.

Figure 33. Location of Danone factory

As it can be seen, it is shown an example of Danone. This company has its own manufacturing site located in Parets del Vallès. Danone has two major distribution policies: on the one hand, the flow of products towards major retailers, and on the other hand, the flow designated for traditional market outlets. Thus, Danone will be responsible of transport its products across road. Specifically, Danone's factory is located 35km from our distribution center.

The Danone's aim is working closely with our supermarket to optimize the flow of products and our inventory levels. This initiative includes efficient consumer response (ECR) which is used to coordinate automatic stock replenishments.

Summary:

Transportation plays an important role in supply chain operations, moving inbound materials from manufacturing facilities to distribution center, and delivering food products to customers.

As has already seen, transportation impacts the service level and transportation costs. Given an understanding of urban distribution, there are decisions to be made regarding transportation management strategies. It is important to carry out an analysis of using private fleets or carriers.

The key is to optimize the strategy based on the company's criteria, which may include higher service levels, required capacities, flexibility and low transportation costs. Thus, transportation should be evaluated to satisfy customer demand.

8.3 Pricing policy

It is necessary that the company decides how much to charge customers for its service. In this case, the online supermarket will offer a large menu of prices in function of desired responsiveness. The company's purpose is to allow that the deliveries are made when the customer want them to be made.

There are key aspects to be taken into account because they affect the supply chain performance. These aspects should be carefully considered:

- *Taking advantage of economies of scale*: The company could offer quantity discounts. A quantity discount is an incentive offered to a customer that results in a decreased cost when purchased in greater numbers. In this sense, the supermarket will be able to sell more goods while the customer receives a more favorable price for those goods.
  Care must be taken to ensure those quantity discounts offered are consistent with the economies of scale.

- *Different prices*: Selecting the appropriate pricing strategy for the company has major implications such as to attract more customers and achieve optimal profit margins. The company must decide what price has to sell the service in order to achieve a balance between expenses and revenues.
  Thus, the company must decide whether it will charge a fixed price for their service or, conversely, have different prices that vary depending on other features, such as amount of purchase or response time.

Taking into account the above and following the example, the customer who has already bought the packet of pasta and the 6 pack of yogurt could decide between different services. The door to door services will depend of the urgency of the customer's order, as follows:

- **Urgent service**: With this service the deliveries will arrive on the same day. It is specific for those deliveries that cannot wait.

- **One-day service**: Urgent transport for shipments to be delivered on the business day following the order. Within the same day different options are offered: before 8.30 am (first hour in the morning), before 10 am and before 14 pm.

- **Saturday service**: Special service through which delivery will arrive not just Monday to Friday but also on Saturday.

- **Standard service**: Basic service of the company, delivery will be in the 2 business day following the order.

- **Free service**: Basic service of the company, delivery will be in the 5 business days following the order. Another free service is the personal pickup in the distribution center.

With all services, except the free one, the customer can decide exactly at what hour their parcels will be delivered through a special service.

Pricing will be based on two factors: the service chosen, which are explained above, and the type of purchase. The price varies between one service and another, between 2€ and 14€. Thereby, the company can use its pricing to provide responsiveness to those who value it, but without forgetting those who want a low-cost service. The strategy is to supply to all types of customers with different requirements. Finally, mention that there will be discounts applied in prices depending on the amount of purchase. Thus, for purchases over € 100 the delivery service will always be free. These pricing decisions were made with the aim of increasing company profits.

8.4 Outsourcing decision

The most important decision for any activity of the supply chain is whether it is possible to outsource or perform the function in-house. When some activity is outsourced, then, it is performed by a third party (3PL – Third Party Logistics Provider). In that case, outsourcing to a third party can provide a sustainable growth of the company's performance.

Activities such as warehousing, transportation or inventory management may be kept in-house. Each of these functions for its own reasons. According to Saayed, M. "Decisions about logistics outsourcing are also influenced by assets and resources of particular company, like facilities or current investments in vehicles or warehouses. Generally companies maintain internally these functions in which their capabilities or knowledge assure efficient and expected logistics performance. Outsourcing decisions might depend on a function's closeness to core business."

Outsourcing is using an external supplier for services to a company that cannot provide them for itself, or cannot provide them in an efficient way. While there are a considerable amount of risks with outsourcing (such as integration difficulties), there are just as many advantages. In general terms, the most important benefits are:

- Minimize overall costs: The company can use the experience and knowledge from third party companies in order to reduce its overall expenses. The 3PL will work to develop the most cost-effective plan possible.

- Flexibility: By working with a 3PL, the company has access to their resources, which means it will have help in creating a more extensive and efficient infrastructure.

- Focus on core business: One of the biggest reasons that companies choose to outsource is to free up time to focus on core business processes. In this sense, the company is able to work on what really matters inside their business, increasing work flow and its business' performance.

- Improved service by exploiting expertise: Having an offshore company handle non-core business activities usually lead to better service.

Cost is always important, but ultimately the success of any global supply chain management process relates to client satisfaction. Outsourcing within the grocery industry has two dimensions: warehousing and distribution. Following, the decisions of each logistic process are analyzed:

Warehousing:

When the company is starting, the decision would be choosing between to buy its own warehouse or renting the space from a third party. If it plans to operate the warehouse itself as part of it business, the costs are high compared to outsourcing.

On the one hand, the reasons to keep warehousing in-house are several. For example, the control of processes (reception of products, storage and picking packing), inventory and data is obviously used more effectively when the company maintains its own storage. So, the company has direct control of insourced warehousing. Then, its customers know that they are dealing with a single company.

On the other hand, there are obvious justifications to outsource of warehousing such as the reduced need for capital investment in warehouse space as well as the reduced cost of sharing versus owning. While there is of course, a cost associated with warehousing as a service, many companies find outsourcing to be a cost saver overall. The reduced need for specially trained warehouse operations staff is also a benefit.

The decision to insource or outsource the warehouse is based on particular business requirements. The important thing though, is to understand the objectives well, and apply whichever model best enables them to be met, without sacrificing any competitive advantage.
In this project, the aim is to have satisfied the customers through a quality service, efficiently and at the lowest possible cost.
So gathering these features, it is considered that the task of warehousing, and all internal processes, will be outsourced to a third party. The reason is because currently there are 3PL companies with a high level of specialization that can add value to the service. Also, in the end, it could be cheaper using the most cost-effective plan possible.

Also, if the chosen warehouse provider can also offer a distribution operation, they can then manage and distribute the goods, leading to even more operational efficiencies.

Distribution:

Effective and efficient vehicle fleet management is a critical point in the supply chain, because it has a significant cost and service impact. This activity is very important because food quality and time deliveries have the highest priority.

In this case, the decision is to choose between third-party carriers and private fleet operations. One of the most important questions that need to be asked is whether or not the cost proposal from the third party carrier is good for the company.

Regarding distribution outsourcing is it possible that the company pays more to have a third party. After all, the logistic carrier needs to make a profit margin which is not the case in a private fleet. However the thinking is that the benefits outweigh the additional expenses because the flexibility factor is so critical to the business. The third party distribution companies enables provides more flexibility. Likewise, it becomes responsible for the planning of deliveries to customers. Scheduled delivery time have to be accepted by both companies.
Thus better overall productivity can be achieved through outsourcing transportation activities.

Despite the many benefits, note that if the external carrier fails, the online supermarket risks losses or damage of the transported products. As it is evident, the distribution of goods needs experienced staff on how to handle each particular product.

It is important to mention that there are currently several companies that use an online-enabled platform to connect passengers with drivers using their personal non-commercial vehicles. This service is offered by companies such as

Uber. It would be interesting to study the possibility to contract this company to deliver the food products from our distribution center to the end consumers. Unfortunately it is not possible to consider this option because it is an illegal and unauthorized transportation in Spain. Despite this, there is a mobile app that offers an express and collaborative delivery service, named Glovo App.

Summary:

Outsourcing logistic activities can provide numerous benefits for the online supermarket and the distribution of food and beverage.

Below it is shown a table with the main characteristics of outsource or insource supply chain processes:

	OUTSOURCING	IN-HOUSE
Warehousing	More flexibility More specialization	More overall costs
Distribution	More quality More efficiency	Less control

Table 8. Main characteristics of outsource

The company needs a provider who is equipped to handle its particular products. As can be seen, outsourcing can enable to be more responsive to consumer demand. It also may be mentioned that this decision is based on operational and cost reasons.
Finally, in order to simplify, it would be interesting to use a single provider who offers warehousing and transportation, allowing the company focus on its core competency.

Chapter 9 Logistics costs

There is no generic definition of logistics costs but every company needs to define it for itself, and the KPI's it will be tracking to lower the costs. Companies have to do a trade-off between cost and performance while managing logistics costs. Through understanding logistics, and the detailed costs involved, is possible to maximize their margins and minimize costs.

In this business case, if tracking of finished products is analyzed, it is observed that these should be displaced from the production area (manufacturer site) to storage (distribution center); kept waiting, along with other products, so far being transported; loaded onto the transport vehicle; transported to the destination; and downloaded, operated and maintained at the destination (point of consumption). These activities incur to **transport** and **warehousing** costs. Additional logistics costs include fuel, packaging, security, materials handling, tariffs and duties.

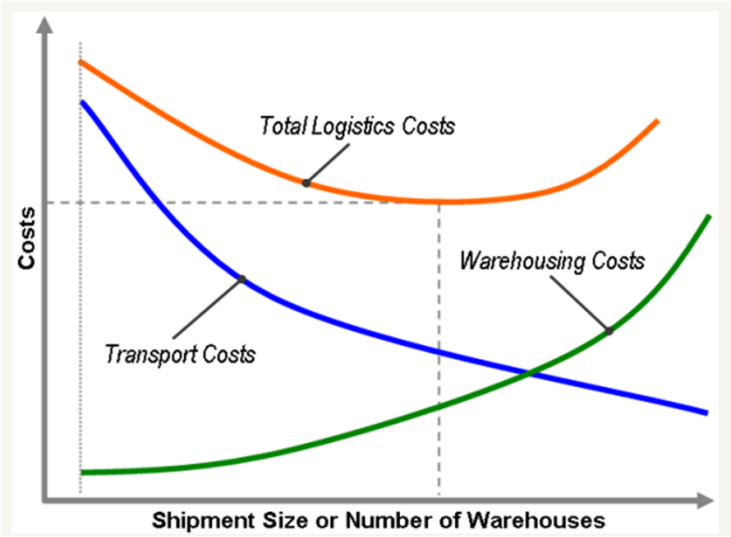

Figure 34. Logistic costs

Transportation costs:

The lowest cost transportation is not necessarily the fastest and hence higher costs need to be incurred to provide higher on time delivery and performance. Also, logistics costs vary depending on the type of goods that need to be transported. The mode of transportation for a perishable good is different from an imperishable good.

Warehousing costs:

Maintenance costs include storage costs (rent costs) and inventory (waiting costs). The first considered renting the space and facilities needed to store products, plus those costs related to the provision of a storage space. The inventory includes costs associated with the value of tangible object, the opportunity cost, etc.

9.1 Analysis of logistics costs

This chapter provides an analysis to model the relationships Business to Consumer (B2C), giving logistic costs needed to carry out this business project in development

Logistics decisions have important economic and financial repercussions not only on the supply chain, but on the entire business world, and often are the ones who determine the success or failure of the business.

First of all, to understand the costs, it should determine the main indicators of demand (volume and number of orders, temporal distribution, etc.) and supply service (quantity and type of vehicles, rhythm service, geographical coverage, etc.).

It would be important to divide Barcelona into different zones in order to make a more detailed cost analysis. As an example of zoning, the Figure 35 shows schematically a zone adopted for the analysis (Sant Gervasi). The study area is divided into 5 zones of smaller size and density of uniform demand, called districts (for which, henceforth, the subscript *j* is used), which are made according to the presence of certain peculiarities in each (functional, geographic, economic). These districts are Sarrià, Les Tres Torres, La Bonanova, El Putget i Farró and Galvany.

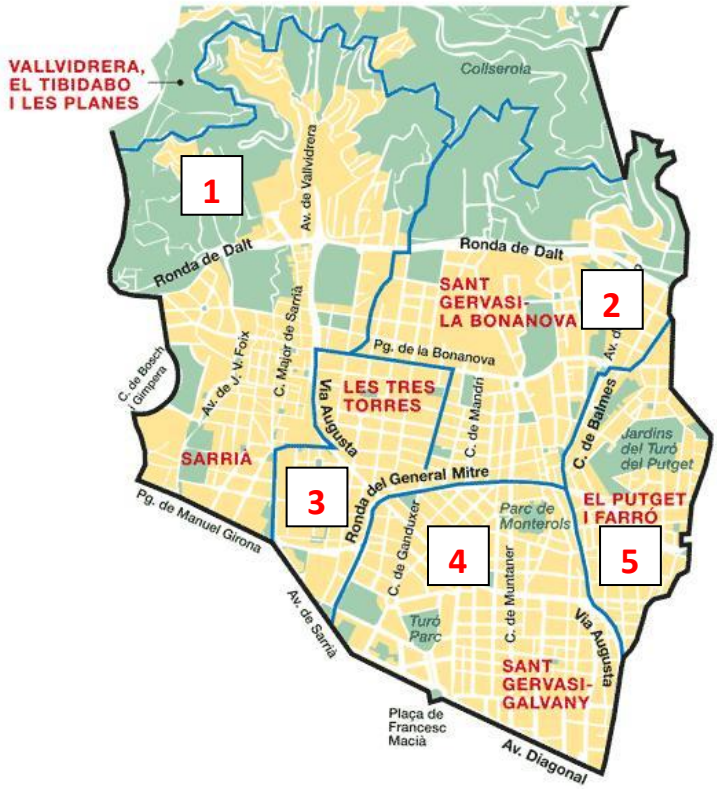

Figure 35. Sant Gervasi district

Furthermore, the region is also divided into *n* service areas (for which, hereinafter, the subscript *i* = 1,..., n is used), which may be greater, equal or smaller than districts, and are defined by the scope of supply for the distribution center.

Finally, these service areas are divided into zones of distribution whose size depends on the maximum capacity of vehicles engaged in the distribution; therefore, if the vehicle has sufficient capacity, the size of the area of distribution can be equal to the service area.

In Figure 37, the service area (Galvany) consists of the delivery zones 1 and 2:

Figure 36. Galvany area

Figure 37. Zonification of Galvany area

Figure 38. Points of consumption in Galvany area

9.1.1 Transportation cost

The total transportation cost of a system from a distribution center (located in El Prat de Llobregat) to many destinations uniformly distributed in the area ***i*** consists of a component that takes into account the cost of the number of stops and other that values the total distance traveled by vehicles. This cost is expressed as follows:

$$P_i^v = P_i^s + P_i^d$$

Where,

- P_i^V Daily cost of transportation in the area *i*
- P_i^S Daily cost depending on the number of stops
- P_i^d Daily cost for the distance traveled

The inclusion of time windows can cause an increase in the variables of the total cost of transport. The total cost of transportation associated with the distribution of a demand orders N*i*, divided into *m* slots, is equal to the cost of distributing the same orders without time windows, plus a differential caused by increased shipments and stops.

To obtain transport costs can be considered two study groups in terms of the relationship between the number of points in the region (N) and the square of the number of stops of a vehicle (C^2).

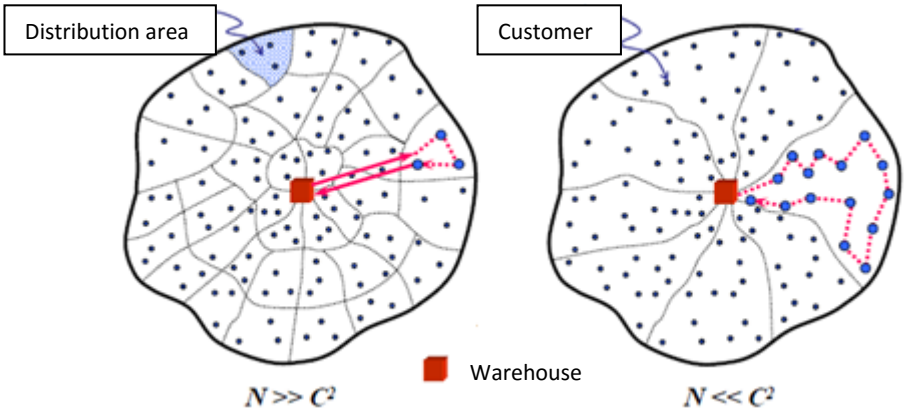

Figure 39. Distribution depending on the number of delivery routes

The first group contains those cases where the number of routes is much greater than the number of stops for each car path ($N >> C^2$), while the second contains that distribution can performing with very few routes ($N << C^2$).

When $N >> C^2$, the total distance traveled by each route takes into account the access distance and the specific deliveries (which considers the separation between points in the area).

When $N << C^2$ can build a TSP for the whole region and divide it into C points that connect to the distribution center. The length of these sections of connection is negligible compared to the total route, and distance is similar to the length of the TSP. In this case the areas are very close to the distribution center; therefore, to calculate the distance it can depreciate the access route, considering only the number of points it wants to visit.

9.1.2 Warehousing cost

To manage the stock successfully, the company needs to find a balance between the costs and benefits of holding stock. The costs of holding stock include the money the company has spent buying the stock as well as storage and insurance. The benefits include having enough stock on hand to meet the demand of its customers.

There is a stock control method called Just-in-time, designed to cut costs by reducing the amount of stock the company holds to a minimum. If the company employs a just-in-time method, it will only keep the exact amount of stock needed at any one point, and its suppliers will hold the rest. For a just-in-time system to work, it is important to be confident that our suppliers can deliver on demand. Note that could be a risk of running out of stock.

Handling cost:

Material handling costs refer to the costs of moving products from one place to another either in the same warehouse.

The distribution strategy affects handling costs depending on the type e-traditional or e-commerce. Overall, the most affected is the cost of handling due to increased picking-packing tasks.

By not having physical stores, the e-commerce process orders in a specific distribution center. The formulation of the cost of handling between the warehouse and the final consumer for each zone ***i*** is:

$$M_i^c = N_i \left(\frac{p_c^f \; v}{v_c} + p_c^v \; v + p_p \right)$$

Where,

- M_i^c Cost of handling in the warehouse and the consumer's home
- P_p Unit cost of picking-packing
- V_c Volume of vehicle

Inventory cost:

Inventory costs are the costs related to storing and maintaining its inventory over a certain period of time. For retailers or wholesalers, as well as for most e-commerces, inventory is usually the largest asset, as well as the largest expense item.

Inventory costs fall into 3 main categories:

- **Ordering costs**: The costs incurred every time you place an order. These costs can be split in two parts: the cost of the ordering process itself and the inbound logistics costs.
- **Carrying costs** (also called holding costs): These costs are a major component of supply chain management, since the business must determine how much of a product to keep in stock. Holding costs of inventory contain hidden fees, such as the cost of purchasing items, housing, handling and accounting for depreciation if those items do not sell quickly. It also includes the opportunity cost of reduced responsiveness to customers' changing requirements.
- **Stock out costs**: The costs incurred when stock outs take place. It can cause cost in terms of customer loss of loyalty or the general reputation of the company.

9.2 Summary

The distribution of products sold online has features that make it substantially different from conventional distribution networks and this often results in an increased demand for resources and costs. Transport operations are one of the main sources of logistics costs; therefore, to analyze the feasibility of a project should know the impact that each decision has on them. The type of reception and the level of service offered are fundamental in defining logistics costs in general and transport in particular.

The type of reception presents alternatives ranging from the staff at the home of the final consumer, until the removal order at the store. The most unfavorable to the distribution system is the personal reception (attended) because it is usually necessary to provide a delivery service with time windows. This generates a low rate of service delivery vehicles because of long lead times and low densities of orders.

If reception is personal, the level of service is closely linked to the size and numbers of slots, since the greater the number of these and lower its duration, the lower the customer waiting at home. This would lead to desire that slots

were as short as possible, but this increased level of attentive service to transport costs so you should do an economic analysis of each situation.

In reference to warehousing costs, as evidenced above, the costs surrounding inventory are significant. Therefore, initiatives meant to reduce the inventory are very valuable – not only do they have an impact immediately measurable on the inventory itself; they also reduce the capital costs, carrying costs, risks and so on.

Chapter 10 Conclusions

10.1 Conclusions of business case

This business case has been used to analyze the distribution of grocery product in urban environments through an online supermarket. The conclusions can be presented as:

- A business approach, that allows to show the feasibility of this type of e-commerce.
- An urban approach, that allows to show the main impacts of Business-to-Consumer in the urban environment studied.

Thus, it has been carried out taking into account the different key aspects related to each other:

- **The demand** will be useful to determinate some entrepreneurial decisions. Thanks to the demand forecasting, the storage capacity can be identified.
- Considering the expected demand, the company should take certain supply chain **strategies**. The first of all is to know the relationship with our suppliers (manufacturers) as well as its location. Knowing this and taking into account the urban area to be supplied, the distribution center is determined as well as the inventory policy and the methodology of transport.
    - **Distribution center**: The distribution center can accomplish the demand of the customer and the supply from the manufacturers. The location of distribution centers is a key element in the design of a company's supply chain.
    - **Inventory management**: The company has different products, each having different logistics characteristics, and therefore need different inventory control rules. The competitive strategy is to achieve a high level of responsiveness and provide prompt service. In order to supply as quickly as possible to customers, high inventory levels will be used in the distribution center.
    - **Transportation**: The distribution center receives items from different suppliers and therefore these items must be selected to be packed and sent to destination. Thus, transportation impacts the service level. Identification of needs vary depending on the level of emergency, the kind of product to be transported, and the area to be supplied.

Through understanding logistics, and the detailed costs involved, is possible to maximize their margins and minimize costs. As seen above, the largest costs are the transportation and warehousing. The company will use the following decisions in order to reduce its overall costs:

- **Pricing**: The company has to decide how much to charge customers for its service in order to achieve a balance between expenses and revenues. In this case, the company will use its pricing to provide responsiveness to those who value it, but without forgetting those who want a low-cost service. The strategy is to supply to all types of customers with different requirements.
- **Outsourcing**: The outsourcing decision is based on operational and cost reasons. The third party companies enables provides more flexibility and minimize its logistics costs.

10.2 Conclusions of the project

In this increasingly competitive market, the companies must find new ways to develop a competitive advantage in front of their rivalry. In order to achieve more competitiveness, the companies have to be more flexible, have greater productivity and have to offer an even better service to the customer, which is always the most valuable agent of any business.

Carrying out this Master Thesis, the supply chain management has been precisely defined and analyzed in order to study a real business case. Thus, the first finding that should be mentioned is that Supply Chain Management is constantly evolving.

Meeting the particular consumer needs is essential to launch a competitive service development strategy. Thereby, depending on the market segment served, the company must have clear in mind the strategies to follow. It is evident that logistics can play an important role by the efficient managing of the flow of goods towards the final customer. To that matter, the main conclusions drawn of the project are:

- The first one is that e-commerce is getting into our lives every day more but the people have still to change their habits from switching the traditional supermarkets to the virtual ones.
- The main factors which explain the correct development of this company in an urban area are road infrastructure, availability of facilities and good distribution network.
- The demand will be the volume that the online supermarket will reach in the established timeframe. This demand will be calculated from the estimated number of buyers to those who are assigned an individual consumption rate. The forecasting has to be accurate to attain a better use of the investment and to prevent losses by making non adequate decisions.
- Depending on the strategy followed, the set of different processes will be done in one way or another. Strategies focus on reduce operational costs and maximizing efficiencies. In this sense, a company following a cost leadership strategy places emphasis on cost reduction in every activity in the supply chain, trying to reach the lowest cost in front of the competitors.
- In order to achieve a supply chain performance, the online supermarket must consider these key aspects effectively: distribution center location, collaboration with partnrs, control of ordering, inventory policies and management of own resources and processes used to deliver products from distribution center to the point of consumption.
- By focusing on the gap between where a company is and where it needs to be, priorities can be set for making improvements. A good example is outsourcing logistics activities which can provide numerous benefits for the online supermarket and the distribution of grocery items.
- On the cost side, e-commerce affects inventory, facilities, transportation, and information costs.

Finally, after all this study and screening it globally, we can say that the implementation of the online supermarket in Barcelona would presumably be a success. This business case could compete in this competitive global market.
Currently some similar companies have announced its launch in Spain. Thus, this gives such a high reliability to the conclusions reached in this project.

References

[1] Sunil Chopra and Peter Meindl, “Supply Chain Management. Strategy, Planning, and Operation”, Pearson Education, Inc., 2007

[2] Michael E. Porter, “Competitive strategy. Techniques for analyzing industries and competitors”, The Free Prss. A division of Macmillan Publishing Co. Inc, 1980

[3] Julie Bennett, “From idea to market: starting a business”, Entrepreneur, 2010

[4] Mckinnon. A, “The effects of transport investment on logistical efficiency”, Heriot-Watt University, 2003

[5] Coyle, Bardi, Langley, “The management of Business Logistics”, 6th Edition, West Publishing Company, 1992

[6] Edward Morlock, “Introduction to transportation engineering and planning”. McGraw-Hill, 1978

[7] S. S. Iyengar and Kianoosh G. Boroojeni, “Oblivious network routing. Algorithms and Applications”, The MIT Press, 2015

[8] Gilbert Laporte, “The Vehicle Routing Problem: An overview of exact and approximate algorithms”, European Journal of Operational Research, 1992

[9] Bodin, L., “A taxonomic structure for Vehicle Routing Problem and scheduling problems”, Computers and Urban society, 1975

[10] Ram Ganeshan and Terry P. Harrison, “An introduction to Supply Chain Management”, Penn State University, 1995

[11] Charles C. Poirier and Michael J. Bauer, “E-supply Chain. Using the internet to revolutionize your business. How Market Leaders Focus Their Entire Organization on Driving Value to Customers”, 2011

[12] Hsiao H.I., van der Vorst J.G.A.J., Kemp R.G.M, Omta S.W.F., “Developing a decision making framework for levels of logistics outsourcing in food supply chain networks”, International Journal of Physical Distribution & Logistics Management, 2010

[13] Holter A., Grant D., Ritchie J., Shaw N., “A framework for purchasing transport services in small and medium size enterprises”, International Journal of Physical Distribution & Logistics Management, 2008

[14] Philippe Wieser, “Essentials of logistics & management”, EPFL Press, 2012